Food and Nutrition in India

By

An Indian Dietarian

FIRST EDITION

3/2, College Street
CALCUTTA
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First Edition published in March, 1947

BY

Dr. D. N. Chatterjee,

3/2, College Street,

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PREFACE

In presenting this book to his countrymen, the author feels happy at the thought that its publication somehow or other synchronises with a time when there is a universal cry for more and more food. Whether this coincidence has any significance or not, the author feels that literature on the subject of nutrition in various forms, should be made available to the general public in increasing numbers, so that they may acquire a first-hand knowledge of what to eat and how to eat. It has been well said "Food properly chosen, properly cooked, and properly eaten is half the battle of life". If this aphorism was true in the past, how much more it is now? It is no longer a secret that the world is faced with food shortage of a tremendous dimension. A crisis of such extent and magnitude has never confronted the world before, and of all countries, India seems to be the hardest hit. Even in pre-war days, India was not self-sufficient in the production of her staple foodstuffs, let alone such "protective foods" as milk and its products, eggs, meat, fish, etc She could, however, then count upon supplies from outside, but the position is changed to-day as the result of the economic disruption caused by the recent devastating war, and India can hardly expect anything like unrestricted imports of foodgrains for some time to come. The situation is further complicated by the increasing pressure of population on land, and all these suggest that the problem of food has come to stay more or less as a permanent feature in India's economy. On a rough estimate, the population of India is increasing at the rate of 5 millions per annum with the agricultural position remaining more or less stationary, and if this phenomenon continues for some time, India will soon be faced with a crisis which will strike at the very root of her social economy. Evidently the situation can be saved only by well-planned activities in various directions, and the one which bears special significance at this stage, is to make the most efficient use of the foodstuffs just

within our reach, in the light of the fundamental truths of nutrition. Here arises the necessity of utilising to the full extent the 'newer' knowledge of nutrition brought forth by Science, and this little book is intended only to be an aid to the study of the subject in all its practical aspects.

A study of the subject of nutrition, however, pre-supposes a knowledge of the fundamentals of Physiology, and naturally the first part of the book is devoted to the elucidation of the elementary principles of this fascinating subject. The writer would point out here that he has taken proper care to present the subject in a readable form to the average man in the street, for whom the book is mainly intended.

The second part of the book covers a fairly wide area dealing with fundamental principles of nutrition, the different constituents of food, their uses in the human body, the properties and composition of foodstuffs, the requirements of a balanced diet, and many other incidental matters, so that any layman of average intelligence can utilise his foodstuffs to the best advantage from the point of nutrition. In developing the subject which is more or less technical in nature, the writer submits that he has done his best to make it intelligible to general readers, and if in doing so, he has given his discourse a turn of class-room study with elaborate explanations and repetitions, he tenders an apology to his more advanced readers.

While the author does not pretend to be an expert on the subject of nutrition, he strongly believes in the dissemination of the knowledge of nutrition as a means to fight what looks like a serious menace to the health and vigour of the rising generation of India. The whole mass has to be made nutrition-conscious if India is to survive in the present struggle for existence. As has been previously noted, the book is particularly written for the illumination of the average laymen, and if they derive any benefit from reading

it, and in their turn, feels an urge to instruct and guide their ignorant countrymen along the right line, the humble author will consider that his labour has not been spent in vain.

In preparing the book, the writer had naturally to consult many standard authors, and he takes this opportunity to express his gratitude to them and apologise for making free use of their publications in bringing the benefits of their rich knowledge and experience within the reach of the general public; and if this book succeeds to some extent in arousing public interest in the subject of nutrition, he should confess that the credit belongs not to him, but to that brilliant band of nutrition workers who have made the fruits of their labour of love more or less public property for the benefits of humanity at large.

The author is also grateful to his numerous friends and well-wishers for the sincere support and guidance he has received from them in writing the book, and finally placing it in the hands of his worthy readers. Thanks are particularly due to Dr. N. K. Brahmachari, M.Sc., M.B., Hony. Visiting Physician to Campbell Medical School & Hospitals, and to National Medical Institution & Chittaranjan Hospitals; to Dr. D. N. Ganguli, M.B., Member, Food Industries Planning, Panel No. 1 (Government of India), Member, International Milk Sanitarians, New York, Director and Technical Adviser, National Nutriments Ltd., Calcutta; and last but not least, to Dr. S. P. Das Gupta, B.Sc., M.B., D. T. M., Bacteriologist to Messrs. Albert David of Calcutta—each of whom revised one or the other portion of the manuscript, giving constructive suggestions for improvement—and all these with good graces. Needless to say that none of them are responsible for such shortcomings that can hardly be avoided in writing a technical subject for the consumption of readers, many of whom lack the background of scientific education.

In this connection, the writer feels that he would fail in his duty if he did not publicly acknowledge his special obligations to two of his personal friends—Babu Bankim Chandra Ghosh of Kidderpore, and Dr. D. N. Chatterjee of 3/2, College Street, Calcutta. It is only in a spirit of duty that they have all along stood by the author in his onerous task, and if the book fulfils its promise, they will have that rare joy which springs from a success with no motive of any personal gain behind it.

In closing, the author should very much like to express his sincere admiration for Babu Monoranjan Sen, B.A., in charge of the Calcutta Printing Co., Ltd., who has only done justice to his old tie with the author as a chum, by taking the publication as his own, and seeing it through the press with that alacrity and promptitude which has raised him in the estimation of the author's associates.

AUTHOR.

January 1, 1947.

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Fundamentals of Physiology

CHAPTER I

FUNDAMENTALS OF PHYSIOLOGY

Human Body

Human body may well be compared to a machine, though it is a living machine, much more complex and complete. Different structures and organs are so contrived and so nicely adjusted as to enable them to perform their assigned duties most smoothly and efficiently. There is a unity of purpose underlying the functions of the various organs, and they all work in perfect harmony for the ultimate object of carrying out the life process. How the various organs so minute and so delicate, perform their individual and collective duties so faithfully, is a thing to marvel at.

Changes in the Human Body

Human body is ever-active. In the performance of their duties, the tissues and organs naturally undergo wear and tear, which need repair or replacement for their continued activity. Thus a process of destruction and construction is constantly going on in the tissues. The worn out tissues are being repaired with new materials, or, in a sense, the old tissues are being replaced by new ones. This interchange of tissues is a constant factor in the human body, and a person's health and vigour is largely determined by the degree of rapidity with which this phenomenon takes place. The sum total of these changes which are of chemical nature, is called "Metabolism". How these changes occur and how the tissues are renewed to carry on their sustained activities, need a close examination. Every act involves the expenditure of some energy which, as we all know, can be generated only by burning some explosive substance. This means that when a tissue works, it must be burning some substance within it to obtain the necessary energy. and when this substance is

completely spent up, the tissue refuses to work. Besides this, with the burning of the substance and the wear and tear of the tissue there accumulate some waste materials in the tissue, which also retard its activity. It may, therefore, be said that for its normal activity a tissue must have an incessant supply of energy-yielding and repairing substances, in a word, nourishment, and also it must get rid of the waste materials. Here we are faced with two questions :—

(1) How to get fresh supplies of these nourishing substances.

(2) How to remove the waste materials.

The answer to these points will be furnished by an examination of the parts played by the blood, the organs of digestion, and the organs of excretion, in keeping the human machine going.

Blood, Blood Channels, and Lymphatics

It is the blood that supplies materials for nourishment to the tissues, and it is again the blood that drains away the waste materials from them. Let us now examine the processes by which these functions are performed by the blood. We should remember that there is a constant circulation of blood in the body, and this is made possible by the existence of a Circulatory Apparatus consisting of the Heart, and three pipe-like channels called Arteries, Capillaries and Veins. The implication of the mechanism keeping the blood in constant motion, is obvious. It enables the tissues to obtain a continued supply of fresh blood for their sustained nourishment and activities, which they would lack if the blood were stagnant. The Heart is the Central Pump which drives the blood through the arteries to the capillaries. These tiny blood-vessels *i.e.* capillaries, permeate every nook and corner of the body, and their fine walls permit the blood loaded with nutrients to pass through to the tissues. The blood then returns through the veins carrying

with it waste materials, to the Heart, to be redistributed as before after undergoing the process of purification in the lungs. Naturally the blood that passes through the arteries, is pure, while that which returns through the veins is impure due to its being adulterated with waste materials. Besides these blood-channels, there are other channels too, which mainly serve the purpose of draining away the waste materials from the tissues. These are known as Lymphatics, the detailed consideration of which will be taken up in due course.

Organ of Digestion and Excretion

The organs of digestion are agencies engaged in elaborating nourishing materials out of raw foodstuffs. These materials are absorbed into the blood-stream which, as we have seen, distributes them to the tissues for their proper functioning. The organs of digestion consist of Teeth, Stomach, Intestines, Liver and a number of other structures, which will be discussed in detail later on.

The organs of excretion are agencies through which the waste products are ultimately thrown out of the body. Among the organs of excretion, the most important are the Lungs, the Kidneys, and the Skin.

Nervous System

We have so far seen that there is some complex substance in the tissue which explodes, and the tissue receives fresh material for explosion from the blood which is itself replenished by the materials received from foodstuffs after they are chemically altered by the digestive system. Now the question arises—how does the explosion in the tissue occur? Does it occur automatically, or through some agency? It has been found by careful observation that it is the nerve-cells and nerve-fibres that stimulate the explosion. It follows then that no movement of any part of the body can occur without an impulse reaching it along the nervous pathway.

Importance of the Digestive System

It is not the purpose of this book to give a full exposition of the anatomy and physiology of the body. Up to the moment, we have made only a brief reference to some fundamental aspects of human machinery in so far as they enable us to understand the broad principles of its working. But as we proceed along with our study, we find that the digestive system requires a more exhaustive treatment in view of its close relationship with the main topic of our discussion, *i.e.*, Food. As we have seen, it is our food and drink that supply the nourishing materials to the blood which carry them to our tissues and organs, keeping them in healthy working condition. We are also aware that our food must undergo some chemical changes before it can gain entrance into the blood. It is the function of the digestive system to effect these chemical changes and make our food ultimately fit for proper assimilation. But before we can follow properly the process of digestion, it is necessary that we should be familiar at this stage with the three principal constituents of food, which are essential for proper functioning of our body. We would here make only a passing reference to them delaying their fuller treatment in the appropriate chapter. It has been found by experiments that a man casts out of his body four elements, *viz.*, Carbon, Hydrogen, Oxygen and Nitrogen. It is primarily the food that restores these four elements, particularly carbon and nitrogen, to the body in proportion to their loss, and necessarily our food must consist of these four elements. The peculiar organism of man does not permit his using them in their elementary forms. They must undergo combinations to suit his organism. The three combinations are Proteins, Carbohydrates and Fats.

Proteins :—consist of all the four elements, *viz.*, Hydrogen, Oxygen, Carbon and Nitrogen with a trace of Sulphur and

occasionally Phosphorous and Iron, as found principally in meats, fish, eggs, milk, cheese, pulses, dried peas and beans etc.

Carbo-hydrates (Starch and Sugar):—consist of Hydrogen, Oxygen and Carbon, as found principally in wheat, rice, sugar, potatoes, etc.

Fats :—also consist of Hydrogen, Oxygen and Carbon, as found principally in butter, cream, oils, lards, etc.

Digestive Process

The digestive system consists of various organs whose main business is to transform food into a condition fit for absorption into the blood and to separate the nourishing portions of food from those which are not nourishing. The matter will be intelligible if we watch the stages through which the food passes from the moment we take it until it is absorbed into the blood and gives us proper nourishment. Food is at first broken down by the teeth and then mixed with a fluid—the saliva—poured out by salivary glands lying in the walls of the mouth and their neighbourhood. Formed into a mass, it is then forced into the back part of the mouth called Pharynx, mainly by the action of the tongue. Muscular movements of the pharynx push it into the gullet from which it passes down into the stomach where it is subjected to the action of a ferment—the gastric juice. A slow movement of the stomach called the peristaltic movement sets in and aids the action of the gastric juice. Between 1 to 3 hours, according to the nature of the food, it is converted into a semi-fluid mixture called Chyme which then passes into the canal of the Small Intestine where it is acted upon by three other ferments—the bile from the Liver, the pancreatic juice from the Pancreas and the intestinal juice from the walls of the Intestine itself. These three juices cause a further break-down of the food, and most of the nourishing elements abstracted from it at once pass

into the blood-stream. From the Small Intestine the remains of the food pass into the Large Intestine along which it proceeds more slowly. The progress here being slow, much of the watery part is absorbed into the system, and consequently the waste matters obtain a degree of greater consistency. Then they are forced downwards to the rectum—the end of the large intestine—through which they are finally expelled from the body as fæces.

CHAPTER II

ALIMENTARY CANAL AND OTHER DIGESTIVE ORGANS

Alimentary Canal comprises the whole length of the canal along which the food is carried. Its average length in the adult is about 30 feet extending from the mouth to the anus. The various parts of the canal bear different names, *viz.*, Mouth, Pharynx, Œsophagus or the Gullet, Stomach, Duodenum (first part of the Small Intestine), Small Intestine, Large Intestine, Rectum and Anus. Each part of the Alimentary canal is entrusted with the duty of performing a particular function or functions, and if any part fails in its duty, the succeeding portions are naturally over-taxed and become liable to be diseased. Besides the Alimentary Canal, there are other organs too, which have an important bearing on digestion. The organs referred to are Liver with its adjunct known as Gall-bladder, and Pancreas.

As we have said, it is not the purpose of our present study to acquire the full anatomical knowledge of the various organs connected with digestion. It is enough for us if we can understand their main features in so far as they affect digestion, and with this end in view, we shall make an attempt to elucidate the functions of the various organs in the process of digestion with a brief reference to the anatomical side whenever necessary.

CHAPTER III

DIGESTIVE ORGANS—THEIR FUNCTIONS

Mouth

The whole mouth is lined with mucous membrane which is essentially the same as the skin, though more delicate and soft. This mucous membrane is continuous with that of the throat, the gullet, the stomach and the intestines. It is beset with little glands secreting a fluid to moisten the mouth, known as saliva.

Mouth contains teeth, tongue and salivary glands each of which plays an important part in the matter of digestion.

Teeth :—It is by means of teeth that we break down food. The more completely the food is pulverised, the more readily it is acted upon by the digestive fluids, and, therefore, the more thorough and quick will the digestion be.

For proper understanding of the functions of teeth in the process of digestion, a brief reference to the structure and arrangement of teeth is necessary.

The teeth are 32 in number—sixteen in the upper and sixteen in the lower jaw. They differ in form from one another, and have different names according to their uses. Thus the four central teeth of each jaw having sharp edges for incising or cutting, are called Incisors. On each side of the central four is one tooth with pointed extremity, *i.e.*, altogether four in two jaws. This is the kind of tooth developed in dogs for tearing, and hence termed the Canine Tooth. Behind the canine teeth there are two Biscupid Teeth on each side (Premolar)—teeth with two cusps or points (eight in two jaws). Then follow the Molar Teeth or Grinders—three on each side with four or five points on each (twelve in two jaws).

It is interesting to note here that in some animals, such as the tiger, the lower jaw is movable on the upper and in one direction only. The upward and downward movement permits of tearing the food. In many other animals, such as the cow, the movement is from side to side, thus permitting only the grinding movement. In man, however, the lower is movable in many directions so that all the movements—cutting, tearing and grinding—are permitted.

The teeth are composed mainly of four substances—(1) Enamel, (2) Dentine, (3) Cement, (4) Pulp.

(1) *Enamel* :—is the outer covering of the tooth. It is the hardest tissue in the body, and as such well-adapted for the purpose of mastication of hard substances. It is composed mainly of phosphates of lime and other earthly salts.

(2) *Dentine* :—is the principal constituent of teeth and lies under the enamel. It is a hard elastic substance consisting mostly of phosphate and carbonate of lime. By way of example, Ivory is the dentine of the Elephant's tusk.

(3) *Cement* :—It resembles bone covering the dentine of the roots or fangs of the teeth buried in the socket.

(4) *Pulp* :—In the very centre of a tooth there is a cavity or chamber known as the pulp chamber which is filled up with pulp —a soft substance containing a rich supply of blood-vessels and nerves. It is the vital part of the teeth, giving nourishment to the dentine and endowing the teeth with sensation.

Tongue

The tongue is a muscular organ which is lined with the same membrane that covers the rest of the mouth. The upper surface is covered with little projections called the Papillæ of the tongue, which are connected with taste. It may be pointed out here that the

acid taste is perceived by the fore part of the tongue, bitters by the back part, sweet and salty tastes by both.

Tongue too has important functions to perform. After the food is thoroughly masticated and moistened by the saliva, the bolus is pushed into the Pharynx by the muscular action of the tongue. It also helps in bringing the different portions of food under the molar teeth during the operation of chewing. Again, it is an organ of taste, and we should remember how good and bad tastes affect our digestion. When a dish appeals to our taste, it excites the secretion of digestive juices, and thus it is more easily digested than an unpalatable dish.

Salivary Glands:—are six in number, the four being situated under the tongue and the jaws, and the two others on the side of the face in front of the ear. The business of the salivary glands is to manufacture saliva which contains an enzyme or ferment. The enzymes are organic compounds which have the catalytic property of changing or breaking down other compounds. The enzyme of saliva known as Ptyallin mainly converts starch into a gummy substance called Dextrin* which in its turn is finally converted into glucose, in which form only starch can be absorbed into the blood, as will be seen from our later discourse. Thus saliva takes the initiative in the digestion of one of the principal constituents of food. By virtue of its moistening property, saliva reduces the food into a consistent mass fit for swallowing. Only a slow and thorough mastication can induce the flow of sufficient quantity of saliva and cause the food to be completely mixed with it. It may be noted here that the actual contact with food is not necessary to the secretion of saliva. The secretion may be induced by the very sight, flavour

*Ptyallin can sometimes convert a portion of the starch into what is called Maltose—a form of sugar.

or even thought of food. This is called psychic stimulation. Saliva is slightly alkaline in reaction, and as such, acts as a natural wash of the mouth, and also as an antiseptic. The salivary digestion does not necessarily cease as soon as the food leaves the mouth, but continues even after it has entered the stomach, as explained later on. In healthy condition, as much as 3 lbs. of saliva can be produced daily.

Pharynx

It is the upper part of the Œsophagus or the Gullet, expanded into a muscular bag. It hangs from the under-surface of the skull above and is four and half inches long. It communicates with the Nose, Ears, Mouth, Œsophagus and Larynx or Windpipe. Thus there are practically five openings into the Pharynx, and the Gullet is the direct continuation of it leading to the stomach. The mucous membrane of the Pharynx is continuous with that of the mouth, the nose, the ears, the larynx and the gullet. Thus the inflamed condition of the membrane in one part may spread to other parts and affect the organs just mentioned.

Functions of the Pharynx :—It has been seen that as soon as the food is masticated and mixed with saliva it is softened into a mass in the form of bolus fit for swallowing. The bolus is then pushed backwards by the tongue into the Pharynx whose muscles at once contract and force the mass down into the gullet. It may be interesting to note here that although the Pharynx opens into four other passages, the food finds its way only into the gullet. The whole mechanism is such that the muscular pillars of these passages begin to contract as soon as the food enters the Pharynx, thus preventing its entrance into them. As will be found from an Anatomical Chart, the Larynx opens upwards into the Pharynx, but the arrangement is such that during the operation of swallowing the mouth of the Larynx is automatically closed by a lid called Epiglottis

which is something like a trap-door. If even a small particle of food accidentally passes into the larynx, one is seized with fits of cough causing a feeling of suffocation—a common experience.

Œsophagus or The Gullet

It is the continuation of the Pharynx and opens into the stomach. It is nine inches long and of the same construction as the Pharynx with its muscular fibres in the walls capable of contracting and relaxing. As has been said, after the food is chewed it is forced into the Pharynx which contracts and in turn pushes it down into the Gullet. The walls of the Gullet then contract in a wave-like fashion and propel the food onwards till it reaches the stomach. Thus we find that the food ultimately passes down into the stomach from the mouth as a result of some regular muscular contractions and relaxations. This is one of the reasons why an animal can drink, though its mouth is below the level of the Gullet, and a man can drink even standing on his head. In other words, the entire act of swallowing is almost independent of the force of gravitation.

Stomach

The stomach is roughly a pear-shaped bag, the upper and the large end of which communicates with the Gullet on the left side just below the Heart. Hence it is called the Cardiac end. The lower and the small end opens on the right side into the upper part of the small intestine called Duodenum, through a valve called the Pylorus or Pyloric gate. This gate prevents the contents of the stomach passing into the small intestine until they undergo necessary preparations.

The walls of the stomach are composed of several layers or coats. The external coat is called the Peritoneum which by exuding a fluid prevents friction with other organs in contact with it. Next comes the coat of muscular fibres whose contractions produce the

peristaltic movement of the walls. This is like a churning movement which helps in the maceration of the food and its mixing with the gastric juice. Then comes the cellular or sub-mucous coat which is more or less a connective tissue binding the muscular coat with the mucous coat. Last of all comes the internal mucous coat continuous with the mucous lining of the gullet. Here we find thousands of glands known as Peptic or Gastric glands secreting the gastric juice which is so important in the process of digestion. Around these glands, there are a large number of minute blood-vessels conveying very fine streams of blood. These blood-vessels have extremely thin walls which separate them from the active cells of the glands. The fine texture of the walls permits blood to pass through into the cells of the glands, and from the blood these glands receive the material for manufacturing the all-important gastric juice.

Gastric Juice :—It has been pointed out that the mucous membrane of the stomach contains innumerable glands busy in secreting a fluid known as the Gastric juice. This juice is acid in reaction, mainly consisting of Hydrochloric acid and a ferment called Pepsin, and also some salts and water. Pepsin acts only on Proteins and has hardly anything to do with the digestion of Fats and Carbohydrates. It is well to remember here that proteins as well as fats and carbohydrates cannot pass on through the membranes to the current of blood in their original forms. Proteins must be broken down into some simple compounds called amino-acids before they can be utilised by the tissues, and in the process of transformation, the gastric juice first splits proteins into substances known as proteoses and peptones, and these are ultimately resolved into amino-acids in the small intestine under the action of various enzymes, as will be evident from our future discourse. Another function of the gastric juice is to reduce the food into a paste technically called Chyme. As soon as the food is reduced to this condition, the Pylorus guarding

the mouth of the small intestine opens itself at intervals, enabling the chyme to pass on. The quantity of gastric juice produced every 24 hours in a healthy body may exceed even a gallon, *i.e.,* 10 lbs.

It may be pointed out here that the gastric juice by virtue of its acidity acts as disinfectant. As the flow of the juice is mainly stimulated by the intake of food, resistance to an infectious germ like that of cholera, is necessarily lower during a fast. It is, therefore, unwise to keep the stomach empty for a long time, specially during epidemics. We should note, however, that to a certain degree there is a continuous flow of the gastric juice regardless of the consumption of food, just like saliva in the mouth. It is also secreted by psychic stimulation resulting from the very sight, flavour and memory of food, but in a small quantity.

Digestion in the Stomach :—We have seen that as soon as the food enters the stomach, the blood rushes in and the activity of the organ begins. The gastric juice secreted by the glands acts upon the food, and converts its proteins into proteoses and peptones. The action of the juice is aided by the churning movement as well as by the warmth resulting from the rush of blood. The churning movement occurs only in the middle and the pyloric regions, and not in the cardiac region which holds the larger portion of the food as a reservoir. As the food in the cardiac region is free from the action of the gastric juice, it naturally retains its alkaline character, thus enabling the saliva to continue its activity, as has been already noted.

We have so far understood that it is mainly the presence of Hydrochloric acid and a ferment called pepsin that causes digestion in the stomach. There is, however, another important ferment called Rennin which produces a curdling action upon milk. The curd is formed by the precipitation of one of the nitrogenous constituents of milk, called Casein, which in turn is acted upon by pepsin, con-

verting it into peptones. It is worth noting here that "curdling is the first stage in the process of digestion of milk in the stomach."

In the process of digestion, the strength of the hydrochloric acid bears an important significance. It has been proved beyond doubt that digestion is imperfect when the acidity of the gastric juice is too low. The lower the acidity of the juice, the more is the gastro-intestinal tract vulnerable to infection carried by food or water. An excess of acid, on the other hand, adversely affects the digestion, as found in the common complaint of indigestion due to the acidity of the stomach.

Small Intestine

We have noticed that the stomach is a pear-shaped organ with its large and small ends. The large end communicates with the gullet on the left side while the small end opens on the right side into a tube called the small intestine—the first portion of which is known as the Duodenum. The tube is about 20 ft. in length and about one inch in diameter, but so "twisted and looped" together as to occupy a very small space in the cavity of the abdomen. It has also four coats similar to those of the stomach. Its muscular layers too, like those in the stomach, propel the food onwards by their alternate contractions and relaxations. Its inner coat—the mucous membrane—is thrown into folds by which the internal surface of the bowel is increased. It is in the small intestine that the bulk of absorption takes place, and the significance of this economic arrangement is obvious. This inner surface is covered with thousands of fine finger-like projections called Villi which give it a velvety appearance. Here in these villi the Lacteals of which we shall speak later on, take their origin. The mucous membrane of the intestine, of course, contains innumerable test tube-like glands which secrete a ferment known as the Intestinal juice (*Succus Entericus*).

Digestion in the Small Intestine:—Up to this, we have found that starch after being converted into Dextrin by the saliva in the mouth, passes on through the stomach into the small intestine, practically without undergoing any further chemical change. We have also found that proteins after being converted into proteoses and peptones in the stomach, ultimately pass on into the small intestine. Now it is for the small intestine to do its duty. In this region, we come across various Digestive Juices or enzymes which act upon all kinds of food—carbohydrates, fats and proteins—and make them fit for assimilation. These juices can broadly be divided into three classes according to their origin—(1) the pancreatic juice coming from the Pancreas. Pancreas* is a long, narrow gland about seven inches in length weighing about three ounces, lying behind the stomach. Its duct opens into the Duodenum and the juice secreted by it daily in a healthy body amounts to as much as 10 lbs.

(2) Bile from the Liver—Liver is a very important gland which will be discussed later on. The bile duct, uniting along with the pancreatic duct, also opens into the Duodenum. In a healthy body, about 3 lbs. of bile can be produced by the liver.

(3) Intestinal juice—from the small intestine itself.

The pancreatic juice is alkaline in character. Broadly speaking, it contains three important enzymes—Amylopsin, Lipase and Trypsin. Amylopsin converts starch into maltose. Lipase (the specific lipase of pancreas is called Steapsin) splits fats into fatty acids and glycerol. Trypsin which is a complex enzyme, splits proteins, previously acted on by the gastric juice, into Proteoses, peptones, Polypeptides, and amino-acids.

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*The Pancreas of an animal is sold in the market under the name of sweet-bread or sweet-gland.

Bile has various functions to perform, the detailed consideration of which will be taken up when studying the structure and functions of the liver. We are here concerned only with its bearing upon the digestion of fats. Bile contains two salts of soda *viz.*, Glycocholate and Taurocholate of soda. These alkaline salts combined with the fatty acids, form soap, breaking up the oil droplets into very fine particles. This emulsification not only increases the solubility of the fatty acids but also allows the lipase of the small intestine to penetrate into the fat more readily for its final absorption.

Intestinal juice contains a number of enzymes, practically covering all the digestive juices hitherto mentioned. The main functions of the juice are to convert proteoses, peptones and polypeptides into amino-acids, and different kinds of sugar, such as sucrose, maltose and lactose, into glucose. The complex enzyme which converts peptones into amino-acids, is called Erepsin. It is worth repeating here that proteins can be absorbed into the blood for building the tissues only in the form of amino-acids, and sugars can be absorbed mainly in the form of what is popularly called glucose.

From what we have said above, it will be found that though the process of digestion begins in the mouth and the stomach, very little, if any, absorption takes place in these organs. It is the small intestine that practically gives finality to the process of digestion by reducing the different food elements to forms in which they can readily be absorbed. Starches converted into dextrin by the Ptyallin of the saliva, proteins into proteoses and peptones by the gastric juice of the stomach, the fats and sugars unaffected by either of these ferments, are all acted upon by the pancreatic and intestinal juices, for the final stage of digestion.

Our study of the mechanism of digestion in the small intestine will remain incomplete if we do not take here a note of one or two more points. We are familiar with the term Chyme which

represents a stage of digestion of the food in the stomach. After entering the small intestine, the chyme undergoes necessary transformation and assumes the name of Chyle It has been seen that the chyme does not all at once pass from the stomach into the small intestine. The food is digested in the stomach in detachments, and as soon as a portion is digested the pylorus opens and permits that portion to pass into the small intestine. It then closes and opens again as soon as a further quantity is ready, and so the process goes on. The chief distinction between the Chyme and the Chyle is that the former is acid in reaction and the latter alkaline. In the chyme the oil floats and does not enter the liquid mixture, while in the chyle the oil is diffused throughout the mixture, and this gives it a milky appearance. It should be remembered here that the acidity of the chyme has a great influence upon the secretion of the pancreatic juice

Now, soon after the necessary absorption in the small intestine, the remains of the food pass into the large intestine which begins in the right side of the lower abdomen.

Large Intestine

It is 5 to 6 feet in length, and is about three times as large in calibre as the small intestine. There is a valve at the junction of the small and the large intestines, which permits the content to pass in one direction only. The three portions of the large intestine are known as Ascending Colon, Transverse Colon, and Descending Colon. The ascending colon passes upwards on the right side till it reaches the liver. It then passes across to the spleen on the left side as the transverse colon and finally descends on the left side to the Pelvis, as the descending colon. The large intestine possesses glands in its mucous coat but neither folds nor villi, as in the small intestine. It contains a number of pouches

which delay the progress of the content, thus allowing the remains of the nourishing material to be fully extracted.

Digestion in the Large Intestine :—Though the large intestine is a part of the digestive apparatus, not much absorption occurs here. The little digestion that takes place, is not so much due to the secretion of digestive juices from the glands as due to the activity of certain minute organisms, called Bacteria. It is said that each day's food is subjected to the action of over one hundred billion bacteria, chiefly in the large intestine. Digestion here is a nature of fermentation whereby the content again becomes acid. We have noted that there are no such arrangements as folds or villi here, as in the small intestine, and this is a fact which rules out the possibility of much absorption in this region. But the pouching arrangement of which a reference has been made, serves a distinct purpose in the process of absorption. By retarding the progress of the content, it allows sufficient time for the blood-vessels to remove its fluid matter.

As the residues become less fluid, they acquire their characteristic consistency and go by the name of Fæces which are driven onwards to the rectum by the contraction of the muscles in the walls of the intestine.

Though the large intestine influences digestion to some extent, its main business is to remove all undigested and indigestible materials, and it may as well be compared to the "Main Sewer" of a city which drains off all the waste materials.

Liver

Though the liver is not a part of the Alimentary canal, it must be taken as a part of the digestive apparatus on account of its both direct and indirect functions in the process of digestion. We have already seen how the bile secreted by the liver directly aids the digestion of fats, and we shall presently see how the other functions performed by it, facilitate the whole process of nutrition.

Liver is the largest gland in the body, weighing about 4 lbs. It is just below the Diaphragm (partition separating the abdomen from the chest) on the right side and practically reaches the border of the chest. It consists of a large number of very active cells which are arranged in groups, each little group being called a Lobule. On the under-surface of the liver, there is a pear-shaped bag known as the Gall-bladder in which the bile is stored up and remains concentrated till it is needed for the digestive process of the body.

The veins from the different regions—the stomach, the intestines and the spleen—uniting into one large vessel called the Portal vein, pass on to the interior of the liver. Coming, as it is, direct from the important digestive organs, the portal vein naturally carries blood loaded with digested elements of food. These elements soon come under the action of the powerful cells of the liver where they undergo further transformation for the ultimate purpose of nourishing the body. Thus the liver holds the main key to the nutritive process of the body, and if it fails to function properly, the body is reduced to a state of starvation and decay with the inevitable consequence—death. Besides this all-important function of the liver, it has other functions which have a very important bearing upon the nutrition of the body as a whole. It is the agent for manufacturing the all-important bile and controlling its secretion. Liver also plays the part, as it were, of a sorter, separating the poisonous substances from the blood for their final expulsion from the body. It splits up the amino-acids, converting their poisonous end-products into a highly soluble inocuous substance called Urea which is ultimately got rid of the body through the Kidneys along with the urine. In the performance of these tasks, the liver distinctly acts as a detoxifying agent. Another important function of the liver is to manufacture glycogen and store it up for future use. The glycogen

is manufactured out of the surplus sugar (glucose) which is not immediately needed for the body heat. Whenever body needs extra heat and energy it is reconverted into glucose, and here also the liver does the duty. Further, the liver stores up a certain amount of fat which is released whenever needed for the life process, and can even manufacture fat out of the materials supplied by the Portal Vein. It may be mentioned here that fat and glycogen are somehow or other antagonistic to each other. A liver rich in fat is generally found to be poor in glycogen and *vice versa*.

All that has been said above, points to the conclusion that the liver is something like a well-equipped laboratory, giving the finishing touch to the process of nutrition by manufacturing new substances out of those supplied by the Portal Vein, by utilising the by-products and eliminating the poisonous wastes for their final expulsion from the body.

Bile and its functions :—Bile contains about 85 per cent of water and 15 per cent of solid matters, the most important of which are the two bile salts and the colouring matter called the bile pigment. The process of the manufacture of the bile pigment is an intricate one, and in our present study we need hardly go into its detailed consideration. It may, however, be noted that the worn-out red corpuscles of the blood are broken down in the spleen, and out of the products of this disintegration the bile pigment is formed.

The bile aids the digestion of fats not only by emulsifying them, but also by stimulating the secretion of a specific enzyme of the pancreas called Steapsin which splits up fats into fatty acids and glycerine. So when the bile is excluded, the digestion of fats is necessarily interfered with.

We are already familiar with the operation which propels the Chyle along the small intestine, and it may be noted here that the

fluid bile also plays an important part in stimulating the muscular movements, thus facilitating the onward progress of the Chyle. Another important function of the bile is that it prevents the putrefaction of the contents of the intestine. These facts explain how constipation results, and also how the stools become foul-smelling and light or dark in colour when there is deficient secretion of the bile, mainly due to the diseased condition of the liver or of the biliary channel.

CHAPTER IV

MECHANISM OF ABSORPTION—LACTEALS AND LYMPHATICS

What is Absorption

In the preceding pages, we have dealt at some length with all the organs of digestion, their functions, and thereby made an attempt at grasping the whole process of digestion. But mere digestion of food is not enough for the purpose of nourishment of the body. The digested food has to be absorbed into the blood before it can be assimilated by the tissues. We may recapitulate here briefly the process of digestion of the different kinds of foodstuffs. Starch is converted into dextrin and/or maltose by the action of the saliva in the mouth and also by the action of the pancreatic juice in the small intestine, and this in turn is converted into glucose by the intestinal juice. Proteins are converted into proteoses and peptones by the action of the gastric juice in the stomach, and they in their turn are converted into amino-acids by the action of the pancreatic and intestinal juices in the small intestine. Fat is split up by the action of the pancreatic juice, saponified by the bile, and then acted upon by the intestinal juice.

All these changes are necessary for allowing the nutrient elements of foodstuffs to gain admission into the blood-current. Now the question may be asked—how can these digested elements of food in the stomach and the bowels pass into the blood-vessels through the walls of the membrane, however thin they may be? The answer lies in the well-known physical process of "Osmosis" which embodies the following principle: "Whenever there are two different solutions separated by a permeable membrane, an interchange will take place between them through the membrane". We have found that in the walls of the stomach and the bowels there are innumerable blood-vessels with a current of blood, and also another fluid containing in solution substances of food. These two liquids are separated from one another by membraneous walls, as said before. The liquid in the stomach and the bowels, holding as it does the elements of food, contains a much larger quantity of dissolved substances than the blood, and as the result of what is called "Osmotic Pressure"* the contents of the Alimentary Canal pass into the blood-stream. We can now understand how food after proper digestion finally gains entrance into the blood.

Lacteal

We have observed how starches and sugars being converted into glucose, proteins into amino-acids, are directly absorbed into the blood. The absorption of fat, however, presents a complicated process, and this brings us to the study of Lacteals. We have so far understood that the digestion of fat is effected by the combined activities of the pancreatic and the intestinal juices, and also the bile salts. At this stage the fat is taken up by vessels called the Lacteal (from the milky appearance of its content—the

*This is caused by what is called "Osmotic pressure." When there is a fluid on either side of the membraneous walls, an interchange between the fluids in the two takes place until they reach an equal degree of concentration exerting the same pressure on both sides.

word lacteal being derived from the latin word "Lac" meaning "milk"). These lacteal vessels, as has been already noticed, take their origin in the villi of the small intestine, and pass through various glandular channels until they reach the main vessel called the Thoracic Duct in the Abdomen, which ultimately pours the content into a large vein at the root of the neck on the left side, called the Left Sub-clavian Vein, thus bringing it into contact with the main current of the blood. In passing through the glands the content of the vessels undergoes certain changes which make it perfectly fit for gaining entrance into the blood. These glands serve the purpose of filtering agents, inasmuch as they separate all the irritating and poisonous matters from the content. They are, therefore, often "subjected to inflamation while the rest of the body is saved".

Lymphatics

In the process of nutrition, it generally happens that the blood-current carries more nutrients to the tissues than are necessary for their nourishment. A question here arises—how are these surplus nutrients disposed of? They are certainly not thrown out of the body, but are somehow or other utilised by it. Now if they are to be utilised, they must be re-absorbed into the blood-stream which is the only medium through which the body can obtain nourishment. Here we find the necessity of some channels through which these nutrients can be restored to the blood, and these channels are called Lymphatics. These surplus nutrients naturally get mixed with the waste substances produced in the tissues as the result of metabolism, and they are collectively called Lymph. The lymphatic vessels are well distributed throughout the body, and they ultimately open into two large veins on the left and right side of the neck, thus enabling them to return the nourishing elements to the main blood-current.

It is impossible to exaggerate the importance of the lymphatic system in our body. We must remember that the lymphatic channels exist in every part of the body, even in the skin. The absorbing power of the lymphatics enable us to introduce medicine into our system by rubbing them into our skin *e.g.*, rubbing ointments. The lymphatics enable a person to absorb water by the skin, even nourishment to a small extent. There are instances in which the sailors short of drinking water, satisfied their thirst by covering their body with wet cloths soaked in saline water of the sea. The injection of medicines is a case in point The medicine is rapidly sucked up by the Lymphatics and absorbed into the blood. This explains how a pin-prick or a small wound can cause blood-poisoning. The effects of smoking are also caused by the Lymphatics carrying the elements of vapour from the lungs to the brain.

CHAPTER V

CARE OF MOUTH, TEETH, AND STOMACH

Care of the Mouth and Teeth

We know that the process of digestion begins in the mouth where the food undergoes some initial preparation for the next stage of digestion. Each part of the Alimentry Canal performs its functions in rotation, and if any part fails in its duties, the succeeding parts are bound to suffer. It is the mouth that first receives the food, and, therefore, it is all the more important that we should be particularly careful about keeping its accessories neat and clean. Among all the organs of digestion, the mouth is practically at our command. It receives what an individual wants to put into it, and performs its functions more or less according to one's will, while other organs perform their functions more or less automatically.

It is certainly a matter of individual choice what to eat and how to eat, and it is here that we make or mar our health. There is some truth in the familiar statement "Man digs his grave with his teeth". Indiscreet eating is liable to cause the break-down of the whole system in the long run, and very well we may say that "Mouth is the first line of defence of the system".

Now taking for granted that we eat the right sorts of food, we are now brought face to face with the subject of mastication in which teeth play an important part. Proper mastication not only excites the secretion of the saliva, but also breaks up the foodstuffs into small particles which are readily subjected to the action of the saliva and also that of the gastric juice in the stomach. Apart from its function in the matter of digestion, mastication also keeps the teeth in healthy condition. When the teeth are given sufficient work to do, there is lively circulation of blood, which keeps them in good working order. It is well said that "not all the tooth brushes nor the tooth powders can do for the teeth and gums what steady and persisting chewing will do".

Hurried eating or what is familiarly called "bolting the food" brings about a series of evils which ultimately recoil upon the teeth. Disturbed digestion resulting from it turns the alkaline saliva into acid which naturally hinders salivary digestion, and also injures the main substances of the teeth, making them more or less ineffective in the business of mastication. The diseased teeth in turn become the hunting-ground of micro-organisms which cause further damage to the teeth. These micro-organisms travel down into the stomach with the food, and ultimately derange the whole digestive system.

Thus, from whatever angles we may consider, proper mastication and healthy teeth which are so closely interdependent, have a very important bearing upon the maintenance of health.

It may be pointed out here that the decay of teeth is often caused by the fermentation of particles of food lodged between them. The fermentation also renders the saliva acid, with all its evil consequences. It is, therefore, necessary that we should be very careful about keeping our teeth clean and properly dressed. Here a word of caution is necessary to those who use tooth powders and pastes for cleansing the teeth. Most of the cheap brands do more harm than good. It is rather better for the poor people to use the sticks of Neem or Acacia. McCarrison says "There is no better way to cleanse the teeth than by the use of a chewed stick of Acacia. If acacia is not available, the first finger may be used instead; either is as good if not better than the modern tooth brush".

It is well to remember here that saliva being alkaline in character, acts as a natural soap for washing the teeth. Therefore, anything that stimulates its secretion necessarily helps the washing process. Acid juices increase the flow of saliva, and, therefore, it is a good practice to suck lemons, oranges etc., after meals.

In this connection, two common diseases of teeth, *viz.*, Dental Caries, and Pyorrhea, deserve passing reference. These two ailments are the direct results of the action of the acid produced by the decompostion of the particles of food that lurk about the crevices of the teeth.

In Dental Caries, the dentine which froms the main bulk of the substances of the teeth, is exposed and attacked by acids owing to the enamel covering it being worn out. In Pyorrhea, the gums are suppurated, and naturally the pus enters into the stomach causing untold harm to that organ, which ultimately reacts upon the whole digestive system.

Care of Stomach

We know that, among the organs of digestion, the mouth comes first in order and then comes the stomach. After undergoing the

initial preparation in the mouth, the food passes down through the gullet into the stomach where it undergoes further preparation for digestion. It is, therefore, natural that if the accessories of the mouth misbehave any way, particularly, the teeth, the stomach, first of all, feels the effect. In view of the close relationship between the mouth and the stomach, it may as well be said that if we take care of the mouth, the stomach will take care of itself. We have already pointed out that among the organs of digestion, only the mouth acts according to our bidding, while other organs act automatically. Yet it can be said that the stomach is more or less under our control, inasmuch as it generally receives what we knowingly put into the mouth. We cannot deny that we very often take too much liberty with our dishes, and it is the stomach that immediately feels the consequence. If we habitually subject this organ to mal-treatment by injudicious eating, the whole digestive system is liable to break down. Stomach may, therefore, be called "the second line of defence of the system".

It has been well said that a healthy stomach indicates a healthy body. Now a healthy state of stomach primarily depends upon the nature of the food taken, and also other factors which more or less influence our digestion. In this connection, the following points deserve consideration :

(1) Nature of food.
(2) Quantity of food.
(3) The length of time between the meals
(4) Cleanliness of teeth, and mastication.
(5) Mental condition.

(1) We know that it is the gastric juice which aids our digestion in the stomach, and the proper flow of this juice is more important than any thing else to keep the organ in a healthy condition. The

juice should not be too much or too little in quantity, nor should it contain too much or too little acid. We also know that the mucous coating of the stomach plays an important part in the secretion of this digestive juice—the glands which manufacture the juice being embedded there. Naturally, therefore, any thing that damages the delicate mucous membrane is bound to affect the normal flow of secretion. This should warn us about the danger of habitually taking hard, corrosive, irritating and too hot substances. Stimulants like alcohol, tea, and coffee, are distinctly harmful if taken to excess, and so also sauces and condiments. Food should neither be very cold nor very hot. It has been found that food digests most readily at normal body heat, say 98°F, and the work of digestion is retarded if the temperature of the stomach is made higher or lower by taking too hot or too cold food. It should also be noted that the gastric juice is by nature warm and if anything too cold is taken, *e.g.,* Ice during meals, it will naturally make the gastric juice less effective. Besides, it will drive the blood away from the stomach where it is most needed, particularly for the manufacture of the gastric juice, as explained before. Excessive drinking of water at meals should also be avoided, as water not only dilutes the gastric juice but also partially removes it from the stomach. It may be taken about an hour after the meal, when the gastric juice will have begun its activity in full vigour. Water should not also be taken just before the meal, but a sip of water, besides moistening the mouth, often acts as an appetiser.

All these facts throw valuable hints as to what we should take and what we should not take in order to keep our stomach healthy.

(2) Food must be taken in moderate quantity. Many people are in the habit of overloading the stomach. This not only interferes with the churning movement, so essential for digestion, but also imposes an extra work on the stomach which is ultimately

weakened. Again, excessive eating requires extra quantities of saliva and gastric juice for the purpose of digestion, and this also involves additional activity of the stomach. Thus habitual overeating ultimately upsets the stomach, causing indigestion with all its evil consequences, as already explained. In this connection, we must remember the well-known maxim "we should eat to live but not live to eat". The safe rule to follow is that one should leave off the table just with a desire to eat a little more.

It may be noted here with interest that when a very full meal is taken, the circulation becomes very active through the abdominal organs, with the consequence that the nervous system and other parts of the body are deprived of their proper share of blood. This is the reason why one feels drowsy after a full meal.

(3) A certain interval must be allowed to elapse between each meal. We shall see during our discourse on "Food", that different kinds of food require different times for digestion. It has, however, been found by experiments that a mixed diet is disposed of by the stomach in about 4 hours. This does not necessarily mean that it is safe to take each meal at the interval of every 4 hours. Stomach requires some rest to renew its energies, and it is, therefore, prudent for us to allow an hour or two more and take each meal at the interval of 5 or 6 hours. Food should be taken not only at regular intervals but also at regular hours. When the hour arrives, the digestive system habitually gets ready to receive the food, and various glands begin to secrete digestive juices in anticipation.

While the time of eating should be mainly determined by the above considerations, there are other considerations too which have some bearing on it. Food should, by no means, be taken unless there is a feeling of appetite. One should not also sit at the table immediately after any hard work, but wait until the feeling of exhaustion is

gone and the stomach is ready to receive the food. Incidentally, it may be pointed out here that one should not also undertake any hard work, mental or physical, immediately after a full meal, as this will drive away the blood from the stomach where it is most needed for digestion.

(4) We have already explained the importance of healthy teeth and mastication in the matter of digestion, and would only make a passing reference to the matter here. Hurried eating brings a series of mischief in its train, ultimately causing a complete break-down of the system. The food passes down into the stomach in masses. The gastric juice cannot easily penetrate into the lumps, and the result is either delayed digestion or indigestion, which reacts upon the saliva, the teeth, and ultimately upon the whole system.

(5) We know that body and mind are indissolubly bound together, and how one influences the other. Mind being a part of the nervous system which stimulates the activities of the various organs, naturally plays an important part in carrying out the vital processes of the body. When mind is disturbed, the peristaltic movement of the muscles of the stomach and intestines, so essential for proper digestion, is thrown out of rhythm. There is also a reduction in the secretion of digestive juices. Thus in cases of worry, pain, anger, fear, depression, and other emotional disturbances, all conditions favourable to proper digestion, disappear. It is believed that in cases of strong excitement, there is sudden discharge of a substance called Adrenaline into the blood-stream, which upsets the whole digestive system. The substance can even travel to the stomach of a child through the mother's milk when she is in an angry mood. This should warn a nursing mother about the danger of feeding her child when either she or the child itself is out of temper.

All these facts point to the importance of maintaining an equable temper and cheerful disposition at meals.

CHAPTER VI

BLOOD AND METABOLISM

What is Blood

We have learnt by this time that the blood is indispensable to our very existence. It is the blood that carries nourishment to all the tissues and organs of the body. It is again the blood that carries the life-giving oxygen from the lungs to the tissues, and removes the poisonous carbonic acid gas and other wastes from the tissues to the excretory organs for their final expulsion from the body. Now what is blood? The blood is not wholly fluid as it looks. It contains little bodies floating in a liquid. The liquid portion is called Plasma or Liquor Sanguina, and the little bodies are the well-known Red and White Corpuscles of blood, and also what are called Palatelets. On an average, one cubic millimeter contains 6,000 to 8,000 white cropuscles and about 5 million red corpuscles, or roughly, in a normal body there is one white blood corpuscle for 500 to 600 red ones. The blood is slightly alkaline in character.

We find that when there is bleeding either external or internal as a result of the rupture of any artery, a clot is soon formed, preventing further hæmorrhage. This clotting property of the blood is due to the existence of a proteinous substance called Fibrinogen in the plasma. As soon as the blood comes out of the blood-vessels, a new substance called Fibrin is formed out of fibrinogen, and it is this fibrin that causes the coagulation. But for the coagulating property of the blood, even a slight wound would be enough to drain out all the blood of the body. In the process of coagulation, the plasma breaks into fibrin and a fluid called Serum. Thus blood minus its corpuscles is Plasma, and plasma minus its fibrinogen is Serum.

Blood forms about 12 per cent of the weight of the body. Of the total weight of the blood a little less than one half is made up of the corpuscles, and the rest is made up of plasma. The red corpuscles consist of about 58 parts of water and 42 parts of solid matters in every 100 parts. The solid parts mainly contain a substance called Hæmoglobin forming about 90 percent of the solids. Hæmoglobin chiefly consists of a nitrogenous body and a colouring matter, together with a small quantity of iron. It has a great attraction for oxygen, and is known as the oxygen-carrier of the body. It looks bright-red in combination with oxygen, and dark in colour when it is deprived of oxygen or saturated with the carbonic acid gas produced by the waste tissues. As we know, the blood carries oxygen to the tissues through arteries, while it carries back carbonic acid gas through veins. Hence the arterial blood is red in colour while the veinous blood is dark. It is by the test of colour that we can often roughly ascertain whether any bloodshed is the effect of a wound in an artery or a vein.

The red corpuscles are manufactured in the bone marrow. After an average life of about 3 to 4 weeks, they are destroyed mostly in the spleen. After the corpuscles are broken down, the hæmoglobin splits into an iron compound and a non-iron compound from which Bilirubin or the colouring matter of the bile is formed. The bilirubin and some other materials of the dead corpuscles which supply the ingredients of the bile, are carried by the portal vein to the liver. The white corpuscles or the Leucocytes are generally manufactured in the Lymphoid tissues and also bone marrow, and to some extent in the spleen. They mainly act as sentries of the system, guarding it against the attack of bacteria, and refusing to give any quarters to them without a regular fight. When the white corpuscles die in fighting, they form what is called pus.

What is Metabolism

At the very outset of our study, it has been briefly explained what is meant by Metabolism. The term, however, requires further elucidation to enable us to understand its full significance. As has been noted, our tissues are undergoing constant changes which are constructive as well as destructive. The former is called Anabolism and the latter Catabolism. Thus, strictly speaking, metabolism means anabolism plus catabolism. The term, however, is used by the Physiologists, not only to signify these two processes but also the processes by which the different elements of food are utilised in the body. Thus we say—the metabolism of protein, fat, carbohydrate, calcium, iron etc. This is a point which should be carefully remembered in following up the future discourse.

TABLES OF WEIGHTS AND MEASUREMENTS

60 grains	equal ...	...	...	1 Dram
1 gramme	,, ...	...	...	15.43 Grains
1 gramme	,, ...	...	...	1,000 Milligrams
1 gramme	,, ...	...	...	1,000000 (Million) Micrograms
28.3 grammes	,, ...	...	...	1 Oz.
16 ozs.	,, ...	...	...	1 lb.
2 ozs.	,, ...	...	...	1 Chatack
1 Kilogramme	,, ...	...	...	**2.2 lbs.**
1 Kilogramme	,, ...	...	...	1,000 Grammes
1 Pint	,, ...	...	...	20 Ozs.
1 Gallon	,, ...	...	...	8 Pints.
1 Litre	,, ...	...	...	33.8 Ozs. (1¾ Pints)
1 Quart				1½ Litres
60 Minims				1 Dram
1 C. C.	,, ...	...	...	16.2 Minims
100 C. C.	,, ...	...	...	3.38 Ozs.
1 Tea spoon	,, ...	...	...	1 Dram
2 Tea spoons	,, ...	...	...	1 Dessert Spoon
2 Dessert spoons	,, ...	...	...	1 Table Spoon
4 Table spoons	,, ...	...	...	1 Wine Glass
1 Wine glass	,, ...	...	...	2 Ozs.
1 Tumbler	,, ...	...	...	8 Ozs.
1 Tea Cup	,, ...	...	...	4 Ozs.

FOOD AND NUTRITION

PART II

CHAPTER VII

FOOD

Food—Its Necessity

In our previous study, we have tried to understand the structure of the various digestive organs and their functions in the process of digestion. We have seen how the different elements of food, after undergoing proper digestion, are ultimately absorbed into the blood-current which carries nourishment to the different tissues and organs according to their needs. In short, we may say that it is the food that keeps the human machine going, and this portion of the book is devoted to the study of the subject in all its aspects.

Nutrition—Its Relation to Food

Before proceeding further in our study, it is well for us to understand the significance of the term "nutrition" and its relation to food. Mere consumption of food does not amount to what is called "nutrition". Nor even its digestion or absorption into the blood. It is only when the different elements of food are properly utilised by the body for its nourishment that we use the term "nutrition" covering all the processes of digestion, absorption and assimilation. McCarrison says "Food is the instrument of nourishment, nutrition is the act of using it." Thus it is nutrition that keeps the body in working order, and not mere ingestion of food for satisfaction of hunger. Body is both a machine and an organism. As a machine it produces energy to do work, and as an organism it grows and decays requiring constant replenishment of its cells and tissues. Nutrition here performs the double function of supplying energy to the body and also contributing to its growth and repair.

Human Body Compared to a Steam-Engine

A man may be compared to a steam-engine. An engine obtains the necessary energy for work from the fuel and water which it consumes. So also a man must consume certain substances in order to obtain from them the necessary energy for the maintenance of his life and activity, and all these substances he obtains primarily from food. Thus we find that food is the source of energy to human machine in the same way as fuel is the source of energy to the steam-engine. It is the combustion of fuel in the steam-engine and of food in the body that produces heat and liberates the energy for work. As the steam-engine is subject to wear and tear, so is also the human machine. It is the duty of the engineer to replace the wear and tear of the engine. So too it is the duty of a man to replace the wear and tear of his body. While an engine mainly requires metal for its manufacture and repair, the human body mainly depends on food for its growth and repair. All these discussions suggest that the main function of food is two-fold :

(*i*) It supplies materials for the growth and repair of the body.

(*ii*) It supplies heat and energy for doing work.

Basic Nature of Food

We have pointed out that the process of metabolism constantly going on in the body, produces waste which is replaced by means of food. It is, therefore, by analysing the waste that we can ascertain to a great extent the nature of food required for the maintenance of our health. We know that we excrete the waste materials of our body principally through the bowels, the kidneys, the lungs and the skin. On an ordinary mixed diet without much roughage, an average man passes out of his bowels from 10 to 12 ozs. material of which about 75 per cent is water and 25 per cent undigested or indigestible remains of the food, by the kidneys about 60 ozs. of

which 95 per cent is water, by the skin about 30 ozs. in the form of sweat of which 99 per cent is water, and by the lungs about 35 ozs. of which 30 per cent is water and the remainder carbonic acid gas. Leaving aside for the time being the undigested solid matter passed out of the bowels, we find that the bulk of the waste substance consists of water, and carbonic acid gas. Besides this, there are certain solid matters found in solution specially in urine and sweat. The chief of these solid matters is called urea which is a natural accompaniment of urine. Now water consists of two elements—Hydrogen and Oxygen: Carbonic Acid gas also consists of two elements—carbon and oxygen—while urea contains four elements, *viz.*, Carbon, Hydrogen, Oxygen and Nitrogen. It then comes to this. There are four constant elements in the waste thrown out of our body, *viz.*, Carbon, Hydrogen, Oxygen and Nitrogen, and in order to replace them, the food must necessarily contain each of these four elements in a quantity equal to that removed from the body. By the way, it should be remembered that there are other elements too, found in the human body, and we shall take them up when examining the chemical composition of the body. In the meantime, we shall try to follow how these four elements indispensable to our life, are made available to the body. It is ascertained by a number of experiments that these elements are of no use to the body as food when they are taken as they are. That is, if a person takes Carbon, Hydrogen, Oxygen and Nitrogen as elements, he will simply pass them out of the body without being able to utilise them. It is only when these elements enter into various combinations that the peculiar organisms of men and animals are capable of utilising them. Now the question is, how are they combined? Here we find what an important part the plants play in the drama of human life. Plants can take them up and build them into compound substances in their bodies under the influence of the sunlight. Men and animals eat plants and thus receive these

elements in combined forms for proper utilisation. They in turn convert them into highly complex substances in their bodies, forming thereby bones, blood, muscles etc. Man consumes animal food too, and naturally uses these complex substances to build his own structure.

CHAPTER VIII

MEASUREMENT OF HEAT—CALORIE

We have found that food supplies heat and energy to the human machine in the same way as fuel supplies heat and energy to the steam-engine. It has been ascertained by science that there is a definite relationship between heat and work—a certain amount of heat always producing the same amount of energy for doing work *i.e.,* both heat and energy are interchangeable in the sense that one can be measured in terms of the other. Here we find the necessity of having a standard measure of heat to express the heat value of a food-stuff in the same way as we express the weight of a thing in terms of pound or seer. The standard unit of heat is called Calorie. A Calorie is the amount of heat necessary to raise the temperature of one Kilogramme (2.2 lbs) of water one degree Centigrade, or when a small standard of weight is used, one gram of water one degree Centigrade. The former is called large Calorie and the latter small Calorie. Most of the nutrition workers use the large Calorie as the basis of their investigation, and figures in our present study are based on it. The unit of heat being determined, the heat values of foodstuffs are naturally expressed in terms of calories. Thus we say such and such a person requires so many calories to do a certain amount of work, or such and such food of specified weight gives so many calories. The calories or heat values of the common food-

stuffs have been found out by burning them in a specially constructed apparatus called "Calorimeter", and we may take these figures as the basis of ascertaining the energy produced by the combustion of foodstuffs within our body, inasmuch as the food burnt inside the body in a sense, has been proved by science to produce the same amount of energy as food burnt outside it. In addition to this, the number of calories required by persons under different circumstances to carry on life-processes and activities, have also been determined and made available to us as the result of modern researches. With all these figures at our disposal, the problem of diet is necessarily much simplified, and the average person can now construct his diet in a way that will give him the necessary calories to carry on his activities. It should, however, be remembered here that there are other factors too which require consideration in the construction of diet, and they will come up for discussion in due course.

Relative Values of Energy-Yielding Food Elements

We remember that food consists mainly of four elements *viz.* Carbon, Hydrogen, Oxygen and Nitrogen. Both Carbon and Hydrogen have a chemical attraction for Oxygen, and they burn in contact with it. This process of burning is technically called "Oxidation" or "Combustion". It is the oxidation that generates heat in the body and gives energy for doing work. We know that the elements of food cannot be utilised by the body if taken in their simple forms. The plants convert them into various compound substances known as starches, sugars, fats and proteins, of which the first three compounds primarily are burnt or oxidised in the body, liberating heat and energy. It has been found by series of experiments that fats yield the greatest amount of energy, and necessarily the foodstuffs which are rich in fats are more energy-yielding than those which are poor in these substances. Next come starches and sugars in order, which are collectively called carbohydrates.

It has been ascertained that 100 parts of fat are equal to about 230 parts of starch and 232 parts of sugar as regards heat-and energy-yielding capacity. That is, the capacity of fat for yielding heat and energy for work is more than double that of starch and sugar. And why? By chemical analysis it has been found that in every 100 parts—

Fat consists of	79	Parts	of	Carbon
	11	,,	,,	Hydrogen
	10	,,	,,	Oxygen
Starch consists of	45	,,	,,	Carbon
	6	,,	,,	Hydrogen
	49	,,	,,	Oxygen
Sugar consists of	43	,,	,,	Carbon
	6	,,	,,	Hydrogen
	51	,,	,,	Oxygen

We have noted above that both Carbon and Hydrogen are combustible substances, and the higher percentage of these substances, *i.e.*, 90 in fat, and the lower percentages in starch and sugar, *i.e.*, 51 and 49 respectively, naturally account for the difference in the energy-yielding capacity of these foods.

Basal Metabolism

In understanding what is basal metabolism, it should be first borne in mind that not all the heat produced by combustion of food-stuffs is converted into external work. Only a certain percentage is manifested in work. In the case of men it is a little more than 50, while in the case of animals it varies from 30 to 40. Now the question arises, what happens to the remainder? It has been

ascertained by experiments that the energy of heat which is not transformed into external work, is not lost, but utilised somehow or other by the body. We know that a man in order to live must maintain the warmth of his body at a certain temperature. The body being in close contact with the external atmosphere which is usually colder than itself, there is a constant loss of heat from the body. This loss of heat must be made up anyhow to keep the lamp of life burning. Moreover, it is a matter of common knowledge that our Heart and Lungs are constantly at work even when we are at rest, and the tremendous amount of work they perform, of which there is no visible sign, can be gauged by the fact that only the work performed by the Heart in 24 hours equals to the work expended in lifting 120 tons to the height of one foot. From the above facts, we understand how the energy provided by our food-stuffs is partly converted into external work and partly utilised by the body for its own maintenance.

The energy thus expended when the body is at rest, is known as the Basal Metabolism. It implies that whether a man does work or not, he demands a certain amount of food to restore the energy lost in carrying out the vital operations of life. The basal metabolism generally increases with the size of the body, as the increased size of the body calls for increased expenditure of energy to maintain the activities of the various organs, such as Lungs, Heart etc. We should remember here that the surface of the body has a greater bearing on the basal metabolism than the weight, because the bulk of the heat lost by the body is from the surface. It is mainly for this reason that the children proportionately require more food than the adult per unit of body weight—the area of the surface of their bodies being greater in proportion to their weights than it is in adult. The basal metabolism of an average adult is said to be one calorie per kilogram (2.2 lbs) of body weight per hour. On this basis, an adult of average size weighing 140 lbs. will require about

1500 calories from his food-stuffs only to keep his body-machine going. He will then require additional calories according to his work. In calculating the basal metabolism of an individual, such factors as age, sex, race, habits, climate etc. which more or less influence it, have to be taken into consideration.

CHAPTER IX

COMPOSITION OF THE HUMAN BODY AND ITS RELATION TO FOOD

We have noticed that the bulk of the waste daily cast out by the human body consists of water, carbonic acid gas and urea. Water consists of hydrogen and oxygen; carbonic acid gas, of carbon and oxygen; and urea, of carbon, hydrogen, oxygen and nitrogen. In other words, we may say that the human body is daily parting with a certain amount of each of these four elements, *viz.*, carbon, hydrogen, oxygen and nitrogen. It is now only a matter of common-sense to understand that these elements must be restored anyhow to the body to keep it going. That is, if the wastes of these elements were allowed to go on without any attempt to replace them, man would continue to consume the very substance of his own body with the inevitable consequence, *i.e.*, death. Are these then the only four elements required for the maintenance of our body? A chemical analysis of the human body reveals that it is composed of at least 18 elements with slight traces of many other elements. Now, the human machine is subject to daily wear and tear just as an engine at work, and the process necessarily involves the waste of each of these elements. Surely we need to replace all these wastes in order to keep the body in working order. We remember that in

the case of the engine the engineer repairs its wear and tear by means of metal, while in the case of the human machine man does it by means of food. It is, therefore, necessary that our foods must contain each of these elements in right proportion for proper functioning of the body.

Elements in the Human Body

We have said that there are chiefly 18 elements found to exist in the human body. They are named below, indicating in percentage the approximate proportion of each of these elements :

Oxygen ...	... 62·0 per cent
Carbon ...	... 21·0 ,, ,,
Hydrogen ...	... 9·0 ,, ,,
Nitrogen ...	... 3·0 ,, ,,
Calcium ...	... 2·0 ,, ,,
Phosphorus	about 3 per cent
Potassium	
Sodium	
Sulphur	
Chlorine	
Iron	
Copper	
Magnesium	
Fluorine	
Iodine	
Manganese	
Silicon	
Cobalt	

Besides these, there are found traces of aluminium, zinc, barium, lithium, etc.

The table shows that the four elements, *viz.*, oxygen, carbon, hydrogen and nitrogen form 95 per cent of the total weight of the body. It must be remembered that practically none of these elements exist in the body in their simple forms—(slight traces of oxygen, hydrogen and nitrogen found as elements being ignored). They are mainly found combined in various proportions to form complex substances in the human body, as already explained.

Compounds in the Human Body

These compounds are divided into two classes :—(i) Inorganic, (ii) Organic.

Inorganic—The inorganic compounds comprise of water and mineral salts. They are called inorganic or lifeless because the elements in these compounds do not require any living agency to make them combine. It is only the chemical attraction that causes these combinations.

Organic—The organic compounds comprise mainly of proteins, carbohydrates and fats. We have already noted how the plant unites oxygen, carbon and nitrogen obtained from air and soil, into various compounds for consumption of men and animals. These compounds are called organic, because the elements comprising them require a living agency, *viz.*, the plant, for their compounding.

Proximate Principles of the Human Body

From the above data, we find there are altogether five principal compounds in the human body, *viz.*, water, salts, proteins, carbohydrates and fats, and they roughly exist in the following proportions :—

Water	... ...	61 per cent
Inorganic or mineral salts	.	5.5 ,, ,,
Proteins	... ...	18 ,, ,,
Carbohydrates	... ...	0·1 ,, ,,
Fats	... ...	15·4 ,, ,,

CHAPTER X

PROXIMATE CONSTITUENTS OF FOOD

In the foregoing Chapter, we have found that the human body approximately consists of five compounds, and the obvious conclusion is that our food also must consist of all these compounds to replenish the waste which has been constantly going on in the body as the result of metabolism. Thus food in its proper sense is made of the following constituents :—

(*i*) Water
(*ii*) Inorganic salts
(*iii*) Proteins
(*iv*) Fats
(*v*) Carbohydrates

(1) Water

Water is composed of two elements—oxygen and hydrogen. It is found in the human body to the extent of over 60 per cent of its weight. It does not undergo any transformation in the system.

Its uses in the Human Body :—It can be rightly said that the human body is aquatic in habit, and without it no function of life is possible. Approximately two-thirds of the body are composed of

water and its indispensibility to the vital processes of life is self-evident. Human body daily loses about 10 ozs. of water in the form of vapour exhaled by lungs, about 30 ozs. in the form of sweat from the skin, about 60 ozs. in the form of urine by the kidneys, and about 6 ozs. by bowels. This loss must be replaced for the continuance of life. Although all our foodstuffs contain a certain proportion of water, the bulk of the loss has to be compensated by way of drinking. An adult of average health should drink at least 5 lbs. of water daily. We know that the body is constantly producing waste material as the result of metabolism, and water acts as the vehicle by which these waste products are removed through such excretory organs as lungs, skin, kidneys and bowels. Water is also necessary to effect the chemical changes going on in the body, and, as a general rule, the more active and important a tissue is, the greater is the amount of water it contains. It is found that an increase in the amount of water taken, generally leads to acceleration of chemical changes, and for the matter of that, the removal of more waste from the body. It is our daily experience that increased drinking of water is followed by an increase in the quantity of urine and sweat, and hence the total quantity of waste substances expelled in a day, would weigh more than that expelled when inadequate quantity of water is taken.

Water naturally plays an important part in the manufacture and secretion of digestive juices, and thus it helps digestion to a great extent. Increased drinking also stimulates the flow of the bile. The increased production of bile generally facilitates the expulsion of waste from the liver, and we know what it means to our health when this important organ obtains such relief.

A very important function of water is that it keeps the blood-stream in a fluid condition. We know that it is the blood-stream which carries the nutritive elements to the tissues of the body, and

in order to maintain the proper circulation, sufficient quantity of water must be taken.

To sum up, water flushes the waste substances from the body, helps in the manufacture of digestive juices, stimulates their secretion, aids digestion, and keeps the blood-stream diluted, so essential for proper circulation.

(2) Inorganic Salts

It is common knowledge that a thing first becomes charred when burning. But when it is completely burned away, a small quantity of ash, white or grey, remains, and this remnant is the mineral part of a substance. It consists generally of potassium, sodium, calcium, iron, phosphorus, sulphur and magnesium, as simple elements. They do not, however, exist in food as elements and it is in complex combinations that they take part in the nutrition of the body. For this reason, the intake of pure and simple ash is practically useless.

Amongst the 32 mineral salts found in the human body, we may name the following just by way of introduction.

Chloride of Sodium
Chloride of Potassium
Chloride of Magnesium
Phosphate of Calcium
Phosphate of Sodium
Phosphate of Potassium
Carbonate of Calcium
Sulphate of Iron
Phosphate of Iron

For our present study, we need not go into a detailed treatment of all the salts. We shall only examine a few representative salts in order to realise their importance in the vital processes of the body.

Uses of Salts :—Although the mineral salts constitute a very small amount of the body weight—say about 6 per cent—they are nevertheless essential constituents. If they cannot be called builders of tissues in a direct sense, they are at least their preservers. They generally give firmness to the tissues, consolidation to the bones, and power of resistance to the body. It is said that the amino-acids into which the proteins are finally converted, are like bricks used for the construction of the body, while the mineral salts are like cement which holds fast its tissues and bones. They are well distributed in all the tissues, fluids and the blood, enabling the body to function properly. They are essential ingredients of digestive juices, and also stimulants to their secretion. They make it possible for the tissues to suck in water and wash out the waste products through the kidneys. They also play an important part in the proper circulation of blood. Thus the mineral salts are indispensable to the nutritive process of the body as a whole. Most of them are alkaline in character, and as such help to maintain the alkalinity of blood on the face of the acid reaction of the waste substances which are being constantly produced in the body as the result of metabolism. Mineral salts are protective in character, and the foods containing these vital ingredients in abundance are called "protective" foods, the detailed treatment of which will be found elsewhere.

Sodium

Sodium Chloride (common salt) is one of the most important inorganic salts in the human body. It is practically found in all the tissues and fluids of the body, but it exists in higher concentration in the fluids. It is constructive in character, contributing to the building of tissues and facilitating the activites of different organs. It controls the exchange of fluid between the blood and the tissues.*

* Osmotic Pressure (see page 22).

The salt stimulates gastric secretion, and is essential to the manufacture of hydrochloric acid which promotes digestion in the stomach.

Too much intake of salt is harmful to the system, and may injure the blood-vessels and also the kidneys in certain circumstances. A person should take 6 to 8 grammes of salt daily; but if he lives exclusively on a vegetable diet, he should take a little more, inasmuch as the potassium of the vegetables having a greater affinity for chlorine, splits up the sodium chloride, and forms into potassium chloride, thus reducing the amount of common salt. It is our common experience how the herbivorous animals like cows, refuse food (gruel) without enough salt, only because they are exclusively dependent on vegetable foods. The carnivorous animal obtains sufficient common salt for its needs from the flesh and blood of its prey.

It is worth noting here that perspiration is very rich in sodium chloride, and necessarily violent exercise results in shortage of this salt, often attended with serious complications. "Miner's cramp" is a case in point.

Potassium

Potassium Chloride is another important salt like Sodium Chloride. It is also a nutrient salt found in all the tissues and fluids of the body, and constructive in character. It is as much essential as sodium chloride to the manufacture of digestive juices in the body. It is more abundant in the tissues as opposed to sodium chloride which occur more freely in the fluids. As both the salts are almost equally important in the process of nutrition, they should exist in the body in almost equal quantity. While the blood corpuscles consist of a large quantity of potassium, they are said to contain very little sodium. It has been found that the deficiency of sodium allows normal growth of rats for some time, but the deficiency of potassium causes premature death.

Iron

Iron is an essential ingredient of Hæmoglobin—the red pigment of the blood. As much as about 70 per cent of the total iron of the body is concentrated in the blood. Hæmoglobin has a great affinity for oxygen and acts as the carrier of oxygen from the lungs to the tissues. It also carries back the poisonous carbonic acid gas from the tissues for its final expulsion through the lungs. Thus hæmoglobin is indispensable to the very existence of our life. As there can be no formation of hæmoglobin without iron, the importance of this mineral in the life process can hardly be exaggerated. Hæmoglobin being the colouring matter of the blood, lack of iron necessarily causes anæmia and general poverty of blood, attended with a feeling of exhaustion. The average daily requirement of iron varies from ·012 to ·015 gram.

Calcium and Phosphorus

Calcium and Phosphorus are found in great abundance in the body. Phosphate of calcium forms more than half of the bones and is also found in a large quantity in teeth along with another calcium salt called carbonate of calcium. It is said that about 99 per cent of the calcium and 90 per cent of the phosphorus in the body belong to the bones and teeth. They also exist in other tissues and fluids of the body. Fluoride of Calcium is another salt which is found in the bones and teeth, but in a small quantity. Calcium is necessary for re-inforcing the coagulating property of the blood and maintaining the normal heart-beats (Myo-cardial tone). The normal contraction and relaxation of the heart depends not on the existence of sufficient calcium alone but also upon the quantitative relationship of calcium to sodium and potassium. Phosphorus is a protective constituent of the nervous tissues, and is essential to the growth of brain.

It is important to remember that calcium and phosphorus are not only essential to the formation of bones and teeth, but a certain

amount of each is indispensable to our very existence. They constantly circulate in the blood-stream, and any continued deviation from the minimum requirement will have serious results. The daily requirements of calcium and phosphorus by an average adult are about 1 and 2 grams respectively. They are required in increased quantities by the mother during pregnancy and lactation, and also by the growing children for the formation of bones. It is believed that for every pound of his body weight, a growing child requires about three times as much calcium as an adult does.

Phosphorus is very widely distributed among foodstuffs, but calcium is a rare element. Foods rich in calcium are generally good sources of phosphorus, but many of the staple articles of diet though containing phosphorus in fair quantities, are poor in calcium. Milk is a good source of calcium, and so also the green leafy vegetables and fruits. However liberal our bills of fare may be, they will be considered deficient unless they contain these two elements in fair quantities.

It is worth noting that calcium holds on lightly to the fibrous structure. So, by extracting juice from vegetables and fruits we get more magnesium or sodium, but by boiling we get more calcium.

Summary

We have made a special examination of the five salts, *viz.*, Sodium, Potassium, Iron, Calcium and Phosphorus, and tried to show how they are absolutely necessary to our life. There are many other salts which, though occupying a more or less subordinate position, are quite important, and their absence is liable to disturb the nutritive process of the body in the long run. These five salts, however, form a class by themselves. They are found practically in all the tissues and fluids of the body and are called catalysers owing to their actions on the various ferments and enzymes, so essential to digestion.

Deficiency of Salts and its Effects

We have so far tried to understand the importance of mineral salts in the human body, and we shall now see how their continued deficiency may throw the whole system out of gear and cause various diseases. We should bear in mind that almost all vegetable and animal foods in their natural condition, *i.e.*, when fresh, contain more or less saline ingredients. But these ingredients are often destroyed by faulty cooking, wrong method of preservation and artificial process of refinement. It has been found that if the preserved food forms nearly the exclusive diet for a considerable period, health is seriously endangered. It is also an established fact that white flour, polished rice, and refined sugar, though possessing high caloric values, cannot sustain a person for a long time if he depends exclusively on such articles of diet. These denaturalised foods are deprived of their salts in the course of milling and refining, and they may be reckoned among "starvation" diets if they are not supplemented by some such fresh and nutritive foods as containing minerals. In fact, as a dietetian says, "white flour and sugar as exclusive articles of diet may destroy life sooner than total abstinence from food, as they quickly break down the tissues by depriving them of various alkaline salts, specially calcium, which are their preservers." These refined foods are distinctly acid-forming, as they are devoid of alkaline elements, and they ultimately affect the alkalinity of blood, and for the matter of that, our very existence. Foods in their natural state seem to contain some "vital electricity and magnetism" derived from the soil. It is believed by many that the mineral salts are "the conveyors of this electricity and magnetism, constantly charging and recharging the human dynamo." Whatever truth there may be in this statement, there is no denying the fact that they hold the key to the maintenance of health. They are in a sense both builders and preservers of all

normel cells and tissues, giving them firmness and power of resistance.

All these facts forcibly suggest that we should depend more on natural foods than on artificial preparations; and if under the stress of modern civilisation and economy we are obliged to take some artificial foodstuffs, we must see that our daily dishes consist also of fair quantities of such natural foods as to provide saline substances in abundance.

Quantitative Requirements of Mineral Salts

Though the mineral salts are necessary in very small amounts, it is well to remember that they should exist in a certain ratio in our diet for perfect nutrition of the body, and this applies particularly to essential salts. The subject offers a wide field for investigation, and we may here make a passing reference to some of the tentative results so far obtained, only to impress upon our readers the necessity of maintaining a certain balance between the different mineral salts. It has been found that the excess of iron reduces the phosphorus content of the body, producing rickets, while the excess of phosphates reduces the iron content. Lack of balance between calcium and phosphorus is believed to be one of the causes of formation of stone in the bladder. Calcium deficiency is said to have an adverse effect on the process of iron metabolism. An excess or deficiency of calcium is found to influence the iodine metabolism, and thus the amount of the calcium content in the body has an important bearing on the disease called Goitre, which is closely bound up with the metabolism of iodine. An excess of potassium, as has already been noticed, reduces the sodium content of the blood, disturbing the whole metabolic process. Excessive intake of magnesium is said to cause calcium deficiency. Many other similar instances may be cited, but having regard to the scope of our book, we need not go into further details.

Table of Daily Mineral Requirements

	Calcium	Phosphorus	Iron
Children	1·00 gram	1·5 gram	12·5 milligram *
Adult (Men)	0·75 ,,	1·5 ,,	10·0 ,,
,, (Women)	0·75 ,,	1·5 ,,	12·5 ,,
Expectant Women	1·50 ,,	2·0 ,,	15·0 ,,
Nursing Mothers	1.50 ,,	2.0 ,,	15.0 ,,

* One milligram = One thousand part of a gram.

NOTE:—There is a wide divergence of opinion among the nurition workers regarding the requirements of Iron. Some recommend even as high an amount as 45 milligrams. To be on the safe side, the figures indicated in the table should be considerably increased.

Sources of Mineral Salts

Mineral salts are found in abundance in the leafy green vegetables and also in fresh fruits. They also exist in varying quantities in many of our common foodstuffs, such as milk, eggs, meat, fish, cereals, nuts etc.

The following table covering most of the important mineral elements in our body with a brief reference to their uses, will prove an interesting study. The first four are chemical elements.

1. *Oxygen*—In juicy fruits and vegetables; makes breathing and living possible.
2. *Carbon*—In whole wheat bread, potatoes, etc.; furnishes energy and promotes growth.
3. *Hydrogen*—In most juicy fruits; promotes secretion.
4. *Nitrogen*—In all protein foods; helps to build muscles.
5. *Calcium*—In green vegetables, particularly leafy ones, milk, butter-milk, cheese, whey, nuts, pulses, yolk of eggs,

small fish (whole), oranges, carrots etc.; builds teeth, bones, makes blood clot, regulates heart-beats, promotes digestion and resistance to disease. Its deficiency retards the healing of wounds, causes degeneration of heart, loss of memory and thinking power.

6. *Potassium*—In almost all vegetables, especially in potatoes, celery, spinach, tomatoes, beet-root, fruits, cereals etc.; keeps tissues young and elastic, helps in the construction of cells, formation of muscles, and in the metabolism of protein and organic salts.

7. *Sodium*—In all juicy vegetables, almonds, cereals, many fruits, and also in small quantities in animal tissues, such as liver, kidneys, etc.; destroys poisons, absolutely essential to health, necessary to the manufacture of hydrochloric acid of the gastric juice, prevents calcium from forming concretions in the tissues.

8. *Magnesium*—In green vegetables, fruits, almonds etc.; develops teeth and bones, and maintains the tone of the nervous system.

9. *Iron*—Raw egg-yolk, liver, kidney, meat, fish, juicy vegetables, cabbage, spinach, carrots, onion, radish, cherries, strawberries, wholemeal flour, oatmeal, legumens etc.; an important constituent of hæmoglobin which is oxygen-carrier, enriches blood and discharges the poisonous carbonic acid gas. It is one of the elements of chlorophyll or green colouring matter in the leaves of plants, without which carbon in the air cannot be converted into starches and sugars.

10. *Manganese*—In cress, parsley, almonds, lettuce, cauliflower, and legumes etc.; works with iron, keeps blood healthy

and red, burns up internal poisons, promotes resistance and improves nerves.

11. *Copper*—The sources of iron are generally the sources of copper. Copper is essential to the utilisation of iron for the manufacture of hæmoglobin, though it is not the constituent of hæmoglobin.

12. *Sulphur*—In raw egg-yolk, onions, celery, cabbage, spinach, radish, oatmeal, wholemeal etc.; makes glossy hair, and is a beautifier, purifies blood and helps the liver to keep up its activity.

13. *Phosphorus*—In cereals specially unpolished, nuts, celery, tomatoes, spinach, radish, cauliflower, carrot, cucumber, milk, butter-milk, cheese, meat, eggs, fish, pulses etc.; repairs and builds nerve tissues, bones and teeth.

14. *Fluorine*—In raw egg-yolk, spinach, cheese, beets, cod-liver oil, etc.; keeps teeth from decay, brightens eyes, helps in the formation of bones and gives power of resistance. Its deficiency makes the bones brittle, and makes a person easy victim to infectious diseases.

15. *Chlorine*—In cabbage, lettuce, cucumber, cocoanut, tomatoes, spinach, celery, pineapples, bananas, dates, whole wheat, peanuts etc.; necessary to the formation of hydrochloric acid of the gastric juice, and also sodium and potassium chlorides; basis of good digestion. It is called the "washerman" of the body, because it expels waste, keeps the joints supple, prevents auto-intoxication.

16. *Iodine*—In onions, egg-yolk, pineapples, cod-liver oil, seameal, sea-salt, sea-water fish, also generallv green leafy vegetables, and fruits grown in soils containing plenty of iodine. Shrimp, crabs, lobster, salmon, oyster

contain a fair percentage, and also some condiments like ginger, black-pepper, coriander and clove. It is pointed out by McCarrison that the Himalayan soil is very poor in iodine. Required in very small amount (the annual requirement for an adult being only one quarter of a grain), helps the body to utilise fats and calcium to the best advantage. Iodine is an important constituent of Thyroxine, the internal secretion of the thyroid gland, and naturally, therefore, the thyroid gland distributes iodine to different parts of the body. It has an important bearing on the metabolism of the body, and its deficiency causes goitre—an enlargement of the thyroid gland, and injures the whole system. It is essential to healthy development of cells, and maintenance of nerve energy. In short, it co-ordinates and regulates the vital functions of the whole system.

17. *Silicon*—In cherries, strawberries, cabbage, celery, spinach, radish, parsnips, cucumber etc; present in very small amounts, makes glossy hair, hardens teeth, makes tissues soft and supple, improves complexion. Its deficiency affects the bones, the teeth, hair and skin.

(3) Proteins

Proteins consist of carbon, hydrogen, oxygen and nitrogen, usually with a trace of sulphur and occasionally of phosphorus and iron. It has been already said that proteins do not admit of assimilation into the tissues until they are broken down into what are known in chemistry as amino-acids. Now, what are amino-acids? They are only a group of chemical compounds which are allied to one another. Each protein is composed of some members of this group, or we may say that each protein is a complex combination of several amino-acids. Professor Lusk says "A single protein consists of a group of these

compounds, somewhat as a word consists of letters, and like letters, the compounds can be combined to give different proteins like different words". This rules out the existence of a single type of protein, and necessarily the proteins differ in chemical structure, though containing the same elements. Up to this time, 20 amino-acids have been isolated, and it is believed that there are many more which await identification. The most indispensable ingredient of proteins, which distinguishes them from other major constituents of food, is nitrogen, and, therefore, they are familiarly known as nitrogenous substances.

The proteins bear different names in different substances. Thus the protein of the muscle is called Myosin, that of the blood, Serum-albumin, that of coagulated blood, Fibrin, that of bones and connective tissues like skin and tendon, Gelatin. Milk contains different types of protein, the chief of which is Caseinogen. The protein of cereals, wheat, corn, etc., is called Glutin, that of the white of eggs, Albumin, and that of peas and pulses, Legumin. Besides the proteins already named, there are other nitrogenous substances found in the body. Thus the ferments bearing on digestion, such as the Ptyalin of the saliva, the Pepsin of the gastric juice, the bile, and also the hæmoglobin or the colouring matter of the blood are all nitrogenous substances. It should be remembered here that not all the nitrogenous substances can be called proteins *i.e.* body builders. As for example, urea and uric acid, the end products of protein metabolism, kreatin, the flavouring matter of meat, though nitrogenous in character, are not proteins.

Uses of Proteins :—The chief function of protein is to supply materials for building and repairing the body. It has been seen that the human body undergoes constant wear and tear which necessarily involves the waste of its proteinous substance, and here we find the importance of protein foods for the replenishment of the waste. The

amino-acids into which the proteins are broken down for ultimate assimilation into the tissues, are, therefore, appropriately called "bricks of the body." In fact, they constitute the very substance of the body, and without them no life is possible on this earth. The very meaning of the term "protein" is suggestive. It is derived from a Greek verb meaning "to take the first place", thus signifying that it forms the basis of the manifestation of life, and as such it is the most essential of all the constituents of food. While the chief business of protein is to furnish the means for growth and repair of the body, it can also, under certain circumstances, generate heat and energy like fats and carbohydrates. Thus, when more than enough protein is taken for the purpose of growth and repair, the excess may undergo combustion providing heat and energy. Also, as in the case of starvation, when the body has already consumed the reserve stock of fats and carbohydrates, the proteins of the tissues themselves undergo combustion to maintain the heat as long as possible. In the ordinary course, however, the proteins do not wholly undergo combustion. The nitrogenous part is separated with a certain amount of carbon, hydrogen and oxygen, and it is the non-nitrogenous part that is combustible, like fats and carbohydrates. This portion produces as much heat as carbohydrate. It is believed that some of the excess proteins may even be stored up as fats and glycogen for the future use in the body, when not immediately required. Proteins often facilitate the combustion of fats and carbohydrates stored in the body. Therefore, a high protein diet is sometimes recommended for slimming, provided the kidneys are in a healthy condition. It should be remembered that the end product of the protein metabolism *i.e.* urea, is to be eliminated through the kidney. Therefore, continued intake of proteins in excess is likely to cause damage to the kidney in the long run. The danger must be guarded against.

Paradoxical as it may seem, it is believed by many eminent physiologists that the intake of too much protein has a tendency to retard development by accelerating the metabolic process in the body. Protein foods are also generally expensive, and, therefore, any superfluous protein in the diet for obtaining energy is unprofitable both "physiologically and financially". The abundance of protein foods also tends to cause gastro-intestinal putrefaction which seriously hampers the vital processes of the body.

It is important to remember that the daily wear and tear of the tissues is not much influenced by the amount of work done by the human body. That is, with increased work there is no increased wear and tear of the tissues demanding extra supplies of protein foods. By way of elucidation, let us take the case of a normal person having his share of nitrogenous foods in a certain definite quantity, and let us examine the quantity of urea passed out by him during a day of work and also during a day of no work. The quantity of urea passed out in his urine and through skin on each of the days, will be found almost the same. Let us also assume the case of a person dependent on an adequate quantity of protein foods for a number of days, the period being divided between work and no work. On examination of his body, it will be found that he has gained no flesh during the period of inactivity nor lost any during the period of activity. The obvious conclusion is that work is done not at the expense of the tissues (*i.e.* proteins of the tissues) but at the expense of the fats and carbohydrates either stored up in the body or taken as food. However, a certain amount of wear and tear of the tissues goes on regardless of the work done, and if the human body is only provided with a quantity of protein daily just to replace the wear and tear (to maintain what is called "nitrogen equilibrium"), all that is required is a quantity of energy-yielding foods, such as fat, starch and sugar, which should be varied according to the amount of work done.

It has been noted that the nitrogenous substances are present in abundance in all the vital fluids of the body, such as blood, nerve matters and digestive juices. This shows that the nitrogenous foods are not only necessary to the growth and repair of the body but also to the manufacture of various ferments, which aid our digestion, of blood which is practically our life, and of nervous matters which stimulate the development of intelligence, memory, power of thinking, reasoning etc.

Different kinds of protein and their relative values :—We shall discuss at length in due course the relative values of different kinds of nitrogenous food. It may, however, be noted here that the value of a nitrogenous foodstuff does not depend so much upon the total quantity of the amino-acid content as upon the character of the amino-acids and the proportions in which they exist in the food. Some of the amino-acids are essential for body building, and some more or less non-essential. The essential amino-acids admit of easy assimilation into the tissues while the others are not so easily assimilated or even not demanded by the tissues. Hence the proteins are broadly divided into two classes—"good" and "poor". The "good" proteins are necessarily of higher biological value than the "poor" proteins, which means that the former contribute to body-building most efficiently and economically. That is, the "good" proteins are readily built into the tissues, and the percentages of their wastage and also of the expenditure of body energy in assimilating them are much less than those in the case of the "poor" proteins.

There is one peculiarity which deserves special mention here. In the case of a mixed diet containing both "good" and "poor" proteins, the amino-acid constituents of the latter are modified to a certain extent in the process of metabolism, and attain a higher biological value. Here is one of the most important advantages of a mixed diet. Generally speaking, animal proteins are considered

to be superior to vegetable proteins, as the former which very much resemble those of the human tissues, admit of easy re-constitution to suit the requirements of the body. However superior the animal proteins may be, it has been ascertained by a series of experiments that, barring milk, they are biologically inferior to the proteins derived from a mixed diet consisting both of animal and vegetable foods. Thus the proteins of meat, fish, and eggs combined with those of cereals, pulses, vegetables etc., are considered not only more useful but also cheaper than any animal proteins taken singly. At any rate, they are as good as any first class single animal protein. Even when the proteins are derived from a mixture of various vegetable foods only, they prove to be more useful than the one derived from a single vegetable food. Most of the physiologists are of opinion that more than 50 percent of the protein in a mixed diet should be of animal origin. Some of the eminent physiologists, however, put the proportion at a much lower level varying from 20 to 30 per cent. It may be noted here with interest that some modern nutrition workers consider that the proteins of a mixed diet of only vegetable origin are as good as those derived from a mixed diet of animal and vegetable foods.

Protein for an Adult:—There has been a considerable controversy among the Physiologists regarding the amount of protein required by an average adult. Most of the modern nutrition workers, however, agree that the protein intake by an average adult should vary between 3 to 4 ozs. *i.e.*, 90 to 100 grams. In any case, it should not be below one gram per kilogram(2.2 lbs.) of body weight or about 2½ ozs.

It should be remembered here that an adult requires protein only for repair of the body, and, therefore, he requires proportionately less protein per unit of body weight than a child who requires it both for growth and repair.

The following table furnished by the Food Committee of the League of Nations will be a valuable guide in estimating the protein requirements at different ages :—

Age	Grams per Kilogram of body weight.
1 to 3	3·5
3 to 5	3·0
5 to 12	2·5
12 to 15	2·5
15 to 17	2·0
17 to 21	1·5
21 and upwards	1·0
Pregnant women 0 — 3 months	1·0
,, ,, 4 to 9 ,,	1·5
Nursing ,, ...	2·0

Protein for Children :—It has been said that proteins are required not only for the repair of the body but also for its growth. Naturally, therefore, the children who need both growth and repair of the body, should take a larger proportion of nitrogenous foods per unit of body weight than adults who require such foods only for the repair of the daily wear and tear which, as has been seen, is not materially increased by his work. Milk, which proportionately contains a higher percentage of protein than other elements of food, is, therefore, considered a very suitable diet for children. Incidentally, we may point out that it is wrong to feed children largely on starchy foods. It is on account of this mistake that many children are found "white-faced from deficient blood with flabby muscles and weak bones". Such kind of diet for children may be called the "nitrogen starvation" diet.

The foregoing table indicates the amounts of protein required

by children at different ages, and it will be seen that their requirements are proportionately less and less with their growth, as the rate of growth generally decreases with age.

Variation of Proteins according to Nature of Work :—It has been noted that the carbonaceous foods mainly provide energy for doing hard work, and naturally, therefore, a brain worker proportionately needs less carbonaceous foods than the manual labourer. If he takes such foods in excess of what is required by his system, he would be doing distinct harm to his health either by placing undue strain on his digestive system or by depositing an extra amount of fat or glycogen in his body.

Now to come to the question of protein foods. From the view points of the repair of the body and of the manufacture of digestive juices and blood, it may be said that the brain worker and the manual labourer are almost on the same footing as to the quantity of protein required by them. But when we consider that the brain work more or less depends on nerve matters consisting of a very large quantity of nitrogenous bodies, we may conclude that the brain worker comparatively requires a little higher proportion of nitrogenous foods than the manual labourer.

Principal Protein Foods :—Amongst the common foodstuffs belonging to the protein group, the names of the following deserve special mention : milk, eggs, cheese, fish, poultry, meat, dried peas and beans, soya beans, pulses, oats, etc.

(4) Fats

Fats consist of carbon, hydrogen and oxygen, the proportion of each element being already noted. They constitute about 16 per cent of the body weight of an average man. Oils are fats with this difference that oils are liquid at ordinary temperature, say at 70°F., while the fats are solid at this

temperature. Mineral oils are not fats. They are known as Hydrocarbons consisting only of Hydrogen and Carbon. The oils of essence though consisting of oxygen, hydrogen and carbon, are also not fats, as their chemical properties are different from those of fatty oils. Their only function is to stimulate appetite and gastric secretion.

Uses of Fats :—As has been seen, 90 parts of fats in 100 consist of carbon and hydrogen (carbon 79 parts and hydrogen 11 parts), both of which are combustible substances. This leads to the natural conclusion that the main object of fats is to provide heat and energy for doing work. We have already noted that the external atmosphere is generally colder than the body which is continually losing its warmth in contact with the cold atmosphere outside, and it is the combustion of fats that keeps up the warmth of the body more than anything else. Thus in cold regions the intake of more fat is necessary than in warm regions, for maintaining the normal heat of the body. An examination of the favourite foods of the Arctic region will corroborate the statement. Even the children there relish fatty foodstuffs more than sweet condiments.

We should remember that it is only by the union of carbon and oxygen, and of hydrogen and oxygen in a certain ratio that necessary combustion can take place. The proportion of oxygen in fats is deficient, and Nature herself provides the extra amount from the air in cold regions. The fact is that the condensed air of cold regions containing more oxygen in a certain volume than the rarefied air in warm regions, enables a man to inhale at each inspiration a larger amount of oxygen necessary for the combustion of the additional intake of fats in a cold climate.

Besides giving heat and energy, fats act as a lubricant to the intestinal tract, protecting the mucous membranes from injury by harmful substances that might accumulate in the system. They

also act as a blanket preventing the loss of heat from the body, and thereby shielding it from chill; make the tissues firm, and protect the system against infection by micro-organisms. They are naturally the medium through which the fat-soluble vitamins are available in the body, as will be seen in the next chapter. They are also believed to promote the flow of bile and pancreatic juices. Thus though fats are not themselves easily digested, they assist in digestion of other elements of food. Lack of fats in the maternal diet is usually found to produce children of less than average weight. McCarrison says "If the food does not contain enough fats, there is a tendency for the feet and legs to swell because water accumulates in them causing a condition called 'Œdema', which is very common in India amongst people whose food contains little or no fats."

It has been already pointed out that work is done not at the expense of the tissues of the body, but at the expense of fats and carbohydrates. We have seen that the urea—the end product of the metabolism of proteins, does not increase in the urine with the increase of work, but the carbonic acid gas and water—the waste products of the combustion of fats, starches and sugars—increase with the additional amount of work, particularly the carbonic acid gas given off by the lungs. This is a positive proof that the work is done at the expense of fats and other carbonaceous bodies and not at the expense of the proteins in the tissues.

When fats are taken in excess of the body requirements, they are generally stored up in the body for future use. When there is continued excess of fat consumption, the excess is not absorbed but remains in the intestine. There it is converted into soap, composed of a part of the fats and an alkali, and as such eliminated from the body as excretion. This excretion of soap brings about a heavy loss from the body of the alkaline bases, such as soda, potash, lime etc., which, if continued, will result in disturbed nutrition. It must

be remembered once for all that the general capacity of an organism for the absorption of fat is limited, and when, for some reason or other, fat oxidation is incomplete, certain products of this incomplete combustion known as "acetone bodies" or better known as "Ketones" are released into the blood-stream. This condition is called Ketosis or Acidosis, and is often caused by the deficiency of carbohydrates—a fact which leads to the conclusion that the human body cannot cope with excess of fats in the absence of carbohydrates. Excess of fats also interferes with the normal digestion of the food as a whole, because the digestive juices cannot readily attack the foods coated with too much fat. This is one of the reasons why fried foods are difficult to digest.

Majority of the physiologists agree that normally an adult should not take more than 2 ozs. of fat, but it may be increased to 3 ozs. according to the nature of work, climatic condition and other factors, and at least one half of the fats in the diet should be of animal origin. There is always some excretion of fat through the intestine, however small in quantity it may be taken, and it is found that the percentage of excretion generally varies in inverse ratio to the amount taken. Fat is, therefore, utilised in the body at its maximum when it is taken in normal quantity, neither more nor less.

The best sources of fats are fatty substances like butter, cream, lard, seed oils, soyabeans, peanut oils, and many other vegetable and nut oils. It should be remembered here that fats can be manufactured in the body even out of superfluous proteins and carbohydrates in the diet. Generally, the softer or more emulsified the fat is, the more quickly is it absorbed. Therefore butter and cream are considered to be the best of all fats.

(5) Carbohydrates

Carbohydrates also consist of carbon, hydrogen and oxygen like fats, but the elements are in different proportion from those in fats,

as has been already noted. Hydrogen and oxygen here are almost in proportion to form water unlike those in fats. Carbon and hydrogen both of which are combustible substances, constitute about 51 per cent of the carbohydrates—45 parts of carbon and 6 parts of hydrogen (starch).

Starch, glycogen, sugar in various forms, gum and cellulose of plants—all fall in the category of carbohydrates. They constitute a very small proportion—not even one quarter per cent—of the body weight.

Uses of Carbohydrates :—It has been seen that carbohydrates consist of two combustible substances existing in fairly high proportion—45 parts carbon and 6 parts hydrogen (starch). Thus their main object is also to provide heat and energy for work, though occupying a subordinate position to fats in this respect. They also conduce to the proper utilisation of proteins and fats in the foods. As McCarrison puts it "Carbohydrates like wood-shavings burn quickly, while the fats like logs burn slowly; so the carbohydrates help the fats to burn properly." Hence the familiar statement "Fat is burnt in the fire of carbohydrates." When there is deficiency of fats in the body, it is the carbohydrates that keep up the heat necessary to the processes of life. If taken in excess of body requirements, the extra amount is generally deposited in the liver in the form of glycogen, known as animal starch, for future use. It is, therefore, generally found that the size of the liver is increased by the intake of more than enough of carbohydrates. We should remember here that the excess of sugar and starch can be transformed into fats in the body. By way of illustration, the wax of the bees is a fatty substance, though the bees are supplied with nothing but sugar. The intake of too much carbohydrate often causes fermentation producing gas and harmful acids, and may retard the digestion of other elements of food. The fermentation may ultimately lead to

diseases of the intestines, such as, Gastric and Duodenal ulcers, and other ailments like High blood pressure, Diabetes Mellitus, Dyspepsia, Constipation, Headache, Skin diseases etc.

The amount of carbohydrate required by an average adult should vary between 14 to 15 ozs. This is the considered opinion of the modern physiologists. It should be remembered that carbohydrates, though readily digested, put some strain on the digestive system. If, therefore, any extra amount of heat and energy is required for any sort of work involving hard labour, it would be prudent to increase the amount of fat along with carbohydrate in the diet, provided one can tolerate the additional intake of fat.

It is, by the way, worth mentioning that during fasting for days together, the reserve stocks of carbohydrates and fats are first burnt and then the protein. This implies that carbohydrates and fats exercise some influence on the protein metabolism *i.e.*, an additional intake of these two elements economises the expenditure of the protein substance of the body. This "protein-sparing" action of fats and carbohydrates can induce even a surplus storage of protein in the body, when they are taken in adequate quantities.

Lusk says "Carbohydrates are the most economical foodstuffs both physiologically and financially. They are the greatest sparers of protein. Ingestion of fat has for its object the relieving of the intestine from excessive carbohydrate digestion and absorption. Ingestion of fat in too large quantities leads to digestive disturbances."

CHAPTER XI

VITAMINS

We are already familiar with the various constituents of food, *i.e.*, water, mineral salts, proteins, fats and carbohydrates. Up to this time we are under the impression that these are the only food elements essential to the proper nourishment of the body. But we are open to correction in this respect, as it is found in practice that these elements are not enough to carry out the vital processes of life. The incidence of such diseases as Beri-Beri, Scurvy, etc., provides illuminating evidence in this connection. It is a matter of common experience that these diseases include among their victims even those who apparently receive all the necessary food elements in their diet. Careful investigations show that the dietaries of the victims of these diseases chiefly consist of such foodstuffs as may be called artificial, *e.g.*, highly polished rice, white flour, preserved foods, etc., and as soon as these kinds of food are replaced or supplemented by natural foodstuffs, such as hand-pounded coarse rice, fresh fruits and vegetables, etc., the diseases show signs of abatement, and gradually disappear. This leads to the conclusion that the foodstuffs in their natural state contain certain substances which are essential for their proper utilisation in the body. Although the chemical nature of many of these substances is not yet wholly known, it is established beyond doubt that they exist in natural foodstuffs in minute quantities varying in their actions, and without them there cannot be any growth and development of the body. Not only this. Their continued deficiency in foodstuffs is liable to cause such diseases as Beri-Beri, Scurvy, Rickets, eac. These diseases are known as "deficiency" diseases, and the foods which protect us from these diseases are known as "protective foods". In view of the fact that these substances are so vitally necessary to the proper

nutrition of the body, they are popularly called vitamins from the word "vita" which means life. The vitamins, it must be remembered , form no part of food elements, as already discussed. "They are only active forces existing in natural foodstuffs with a stimulating influence, and their functions may be likened to those of electric sparks in the forming of the organic combinations, essential to growth." They are organic compounds required for the normal growth and maintenance of life of men and animals. They do not furnish energy, nor do they build or repair tissues, but they are necessary to the transformation of energy and the regulation of the metabolism of the tissues. In other words, they do not nourish the body by digestion as other foods do, but cause the foods to be assimilated in the body. They are generally synthesised by plants, and as a rule, men and animals cannot synthesise them. They mostly occur in plants, and are found in the animal organism only as a result of food intake. They are readily absorbed in the intestinal tract and are carried by means of the blood-stream to the tissues and organs which need them. The vitamins are not antagonistic to one another. Administration of excessive amount of vitamin usually causes its excretion within a short time. It yet remains to be definitely established whether vitamins have got any toxic effect.

The existence of vitamins was discovered sometime before the first world war in 1914. Since that time the subject has been under close scientific investigations which have led to the discovery of a number of vitamins and many new facts about them. Though the last word as to the exact number of vitamins and their nature has yet to be said, it has been possible for Science not only to extract and isolate several vitamins from the rich natural resources, but also to manufacture them in the chemical laboratories. The latter are known as synthetic vitamins. Nearly a dozen or more vitamins can now be artificially prepared, which has resulted in the substantial reduction of prices, and it is now possible to place them within the

reach of the poorer classes who need them owing to the deficiency of "protective foods" in their bills of fare. The isolation of vitamins in pure form and the elucidation of their chemical structure which resulted in the synthesis of various vitamin compounds, cover a period beginning from 1920, when the first vitamins were obtained in crystalline forms. In this period the following vitamins were isolated—Vitamins A, B_1, B_2, B_6, C, D, E & K. Subsequently, vitamins H & P were also identified. Besides these, there are many vitamins which still remain to be identified, or have a very shadowy existence. No evidence has yet been found as to the actual part played by them in the maintenance of health. In any case, the list of vitamins is not yet complete, and more work has to be done before all the vitamins are isolated. It appears, however, that those vitamins the absence of which causes the most obvious "deficiency" diseases, are all known; and in a small treatise like this, we shall make a short survey of only those vitamins which have been identified and which are of immediate concern to us. The four principal vitamins which have been found by conclusive evidence to have a distinct bearing on the nutritive process of the body, are A, B, C, D. As to the other identified vitamins, there is not much direct evidence yet as to their actual values in the life processes. It is often the practice to divide the vitamins into two groups—the fat-soluble like A, D, E, and the water-soluble like B & C. A certain difference exists between the physiological action of the water-soluble and fat-soluble vitamins. All the fat-soluble vitamins along with the water-soluble vitamin C regulate the metabolism of the tissues. The water-soluble vitamins excepting C mainly regulate the mechanism of the transformation of energy, *i.e.* the carbohydrate metabolism.

Vitamin-A

This is not a single vitamin, and contains at least two members A_1 and A_2. It is soluble in fat, and can be almost called an exclusively

animal product. It is chiefly found in butter, cream, ghee, milk, cheese, egg-yolk, liver of animals, fish-liver oil, animal fats except lard. It is also present in the vegetable kingdom, but in a form known as Carotene in Chemistry, which is not the actual vitamin A. The Carotene is a hydro-carbon substance (consisting only of hydrogen and carbon) which is formed by the action of the sun, mainly in the leaves of the plants, and this in turn is transformed into vitamin A in the liver of men and animals. It is, therefore, called the "precursor" of vitamin A or pro-vitamin A. Green leafy vegetables are naturally richer in carotene than roots and tubers which cannot receive the direct rays of the sun. Even in leafy vegetables themselves, the outer parts which are green, contain more carotene than the inner parts which are white, as in the case of cabbage. Some leafy vegetables contain abundance of carotene, such as Amarnath leaves (Lal Sag), Coriander leaves (Dhaina Sag), Drumstick leaves (Saijna Pata), Neem leaves—tender, Curry leaves (Bursunga), Celery leaves (Ajwan Pata), Ipomea leaves (Kalmi Sag), Fenugreek leaves (Methi Sag), Gram leaves, Betel leaves (Pan), Spinach, Cabbage, Lettuce. Among the roots and tubers, Carrot is the only vegetable which is a rich source of carotene. Most of the fruits when ripe, more or less contain carotene, and those which deserve special mention are Mangoes, Papyas, Dates, Tomatoes, Jackfruits, Oranges and Bananas. Carotene has a special attraction for yellow colour. There are some vegetables and fruits which lack it when green, but develop the same when the colour is turned yellow *e.g.*, green tomatoes, mangoes and oranges cannot have it until turned yellow or red. The vitamin content is mostly stored in the leaves of the vegetables and the liver of animals. Small fish obtain it from the water-weeds, and big fish in turn derive it through the medium of small fish which are their prey. Therefore, the entire small fish and the liver oils of big fish like Cod, Shark, Halibut, Saw-fish etc., are rich sources of this vitamin. It is absent or very deficient in

vegetable oils, such as Cocogem, Vanashpati and also in yeast, sugars and starches. But Red Palm oil obtained from the fruit of a tree principally grown in West Africa, Malaya and Burma, is very rich in carotene, and is being used as a substitute for Cod-liver oil, as far as vitamin-A is concerned.

Vitamin-A promotes growth, and is, therefore, specially necessary for the growing men and animals. It is very closely connected with the early development of infants, and, therefore, the pregnant and lactating women must have enough of this vitamin. Its deficiency stunts growth, and is responsible for many cases of premature and still-birth. It forms an essential part of one of thė "sensitive pigments in the retina," and lack of it often leads to night-blindness and many other diseases of the eyes, such as Corneal ulcer, Keratomalacia, Xeropthalmia etc., leading to total blindness. Its deficiency also has deteriorating effects on the skin, on the mucous membranes of the respiratory and alimentary tracts, and also of the urino-genitary system. These passages have a remarkable power to resist the attacks of Bacteria, and, therefore, when deranged, they naturally become vulnerable to infection, causing many ailments, such as inflammation of the eyes, ears, nose, throat, lungs, stomach, bowels and kidneys. This vitamin is, therefore, called "the first line of defence against infection." "Toad Skin" in which the skin becomes dry and rough is attributed to the lack of this vitamin. It is believed that its deficiency is one of the causes of formation of stone in the bladder.

This vitamin is not normally affected by heat except in the alkaline solution. Cows obtain carotene specially from green pastures, and it is for this reason that the summer milk contains more of this vitamin than the winter milk. Human milk is richer in vitamin-A content than cow's milk.

Vitamin-B

It is a complex vitamin, soluble in water It was originally supposed to be just one element, but is now found that there is a variety of this vitamin, which are known as B_1, B_2, B_3, B_5, B_6 (Pyridoxine), Pantothenic acid and so on. Generally vitamin-B is found in whole cereals, yeast, milk, cheese, egg-yolk, nuts, oatmeals, fruits, peas, beans, pulses, cabbage, spinach and in roots like potatoes, beets, etc., and to some extent, in the glandular parts of animals. It is very abundant in yeast, the embryo and the silvery skin of cereals, but in such seeds as beans, peas, it is more distributed through their substance. It is not easily destroyed by acid, but is affected by alkalies, *e.g.*, carbonate of soda, and, therefore, common soda should not be used in boiling pulses and other edibles. It withstands heat to a fair degree, if not too prolonged. Vitamin-B_2 is found to be less sensitive to heat than Vitamin-B_1. As it is soluble in water, the fluid of the cooked rice containing the bulk of the vitamin should not be thrown off.

It promotes growth like vitamin-A, and its deficiency in mother's diet is also believed to be often responsible for œdema, hæmorrhage, abortion, and still-birth. The deficiency of vitamin-B_1 is particularly the cause of the disease known as Beri-Beri which is attended with nerve complaints. On account of its effects on nerves, it is called the Anti-neurotic vitamin. Beri-Beri is associated with various symptoms, such as "shortness of breath, paralysis, œdema, numbness with loss of sensation, specially in hands and feet". It is generally prevalent among the poor rice and wheat eating peoples because of the polishings and brans being removed from the seeds by high milling. It is in these coatings that this vitamin mainly exists.

Vitamin-B_1 regulates the metabolism of carbohydrates in the body, and, therefore, its requirement is in proportion to the consump-

tion of carbohydrates. It increases appetite, and its deficiency is often the cause of sudden loss of appetite. Without this vitamin the cells of the nerves and heart muscles cannot burn carbohydrates, and, therefore, they are deprived of sufficient energy, and diseases of the nerve and heart result. It may be noted that while this vitamin is necessary to the combustion of carbohydrate, it is not so in the case of the other energy-yielding substance *i.e.* fat. Fat, therefore, has what is called "B_1 sparing" action. This vitamin is identified with a substance called Aneurin hydro-chloride, familiarly known by the nomenclature "Thiamin."

Vitamin-B_2 is complex and contains at least three different substances. One of these called Riboflavin, primarily promotes growth by inducing oxidation and the other two partly promote growth and partly prevent certain morbid condition of the skin. Yeast contains both vitamin-B_1 and B_2 complex. In Pellagra, a mortal disease, which is generally prevalent among the maize-eating peoples, yeast is effective at the early stage. But it is not the Thiamin nor the Riboflavin of B_2 complex that effects the cure. It is some other substance of B_2 complex that is concerned, and it is now known as Nicotinic Acid or shortly "Niacin." "Black tongue" in dogs is also cured by nicotinic acid.

The deficiency of Riboflavin for quite a long time is a distinct menace to our life. It disturbs digestion, depresses nerves, and brings about a condition of general weakness. It also affects eyes and skin. In short, its continued deficiency often causes the breakdown of the whole system. A man becomes prematurely old with the span of life very much shortened. A common disease prevalent among the poor Indian children with soreness of the mouth and tongue and white patches at the corners of the lips, is caused by the lack of this complex vitamin. Riboflavin is principally found in yeast, egg-yolk, liver, whole wheat, milk, dried milk, meat and fish,

and Nicotinic acid in milk and its powder, whole wheat, meat, liver, dried peas and beans.

Vitamin-C

This vitamin is identified with ascorbic acid, and is soluble in water like vitamin B. It is found in fresh vegetables and fruits, and also germinating pulses. It is specially abundant in citrus fruits like lemons, oranges, grapefruits, Pomeloes, and also in berries, tomatoes, apples, potatoes. The Indian Amla fruit (Amlaki) is particularly very rich in this vitamin. The juice contains nearly 20 times as much vitamin as the orange juice of the same quantity. Paprika (Hungarian pepper) is a very rich source of this vitamin. Leafy vegetables contain it in larger amount than the roots and tubers. It is absent in cereals, such as wheat, rice, barley, maize, and also pulses. The vitamin content of green vegetables and fruits increases slowly during growth and reaches its maximum just when the fruit is ripe, and thereafter it decreases steadily. The special characteristic of this vitamin is that it disappears during the aging of foodstuffs. It exists in fair amount in milk; but as it cannot withstand much heat, milk is very liable to lose it by unnecessary boiling. Human milk contains a little more of this vitamin than cow's milk.

As this vitamin is wholly or partially lost in cooking, raw vegetables and fruits should form part of our menus. There is further loss of the vitamin if the cooking water in the can is thrown away, or if the vegetables are kept hot after cooking, or if the raw vegetables are stored too long after they are picked. It is a very sensitive vitamin, and baking powder may destroy it in a few minutes. But acidity exercises a protective influence on this vitamin to a certain extent, and hence the practice of adding a small quantity of tamarind juice to the cooking water is quite scientific. Salting of fruits is said to be a good method of partially preserving this vitamin.

The fruits are first immersed in hot water for a few minutes, and then kept in concentrated salt solution.

Generally, the tissues of high metabolic activity have the highest vitamin C content. Thus young tissues contain more of this vitamin than the old tissues, and young people have more vitamin C reserve than elderly people. It acts on the skin, and not only keeps the blood in good condition but also helps in maintaining its right composition. It is believed to aid other vitamins in their action. A liberal supply of this vitamin increases the resisting power of the body, specially against infectious diseases, such as Tuberculosis, Diptheria, Rheumatic fever, Arthritis, Dental Caries, and Pyorrhea. It is indispensable to the healthy structure of teeth. A very important function of this vitamin is that it acts as a cement to the walls of the blood-vessels, thus providing protection against hæmorrhage. Vitamin C has the special power of detoxifying a large variety of toxic compounds including the toxic doses of other vitamins, if any.

The deficiency of this vitamin exposes one to the attack of scurvy, and, therefore, it is called Anti-Scurvy or better known as Anti-Scorbutic vitamin. This disease is associated "with sponginess of gums, looseness of teeth, fragility of bones, paleness of complexion, lethargy, intense pain and hæmorrhage in all parts of the body, and often Œdema."

Vitamin-D

There are at least three forms of Vitamin D, if not more. The individual members are provisionally named D_2, D_3, D_4, etc. It is found chiefly in fish with much body oil. Abundant quantities are present in their liver. While the fat of fish contains relatively large amounts of this vitamin, the fat of other animals contains little or none. The only exception is found in the case of animals, specially those birds, which principally live on fish. It is very abundant in

the Cod, Halibut, Shark, and Saw-fish liver oils. It is also present to some extent in milk, butter and ghee, eggs of birds, the yolks of hen and duck eggs. The parent substance of this vitamin is present in the human skin as pro-vitamin called Ergosterol, and it is readily converted into vitamin D under the action of the ultra-violet rays of the sun. The incidence of rickets is, therefore, rare in countries with bright sunshine and a lot of outdoor life.

The main function of vitamin D is to help in building bones and teeth. The growth of men and animals is positively retarded in the absence of this vitamin. Its deficiency causes the incidence of rickets in children, and hence it is called Anti-Rachitic vitamin. In this disease, the bones are not properly developed and become unusually soft. The disease is also found among the adults, and it is then called Osteomalacia. Women are particularly the victims of this disease during pregnancy, because the bones of the embryo have to be formed out of the materials of the mother's body. It has been seen that the bones chiefly consist of two minerals, *viz.*, Calcium and Phosphorus, and that these two salts must be in a certain ratio in the blood-stream for the maintenance of our system. The presence of these two salts is not enough for the construction of bones and teeth. There must be some agency to activate them, and here we find the necessity of vitamin D which has an important bearing upon the calcium and phosphorus metabolism. It restores the balance between calcium and phosphorus, and also aids in their retention and absorption. It must, however, be borne in mind that without sufficient supply of these two salts vitamin D alone is incapable of building or repairing our bones.

Vitamin D_2 has been identified and is known as Calciferol. This member of the vitamin D is consideerd to be mainly connected with the incidence of rickets.

Vitamin-E

It is a fat-soluble vitamin, and known as Tocopherol. There are at least three kinds of vitamin E. This vitamin is widely distributed in foods and occurs chiefly in plants. The best natural source of this vitamin is vegetable oils, *e.g.*, wheat germ oil, cotton seed oil, etc. Olive oil does not contain any. It is found in fair quantities in Lettuce and Alfalfa, and in small quantities in oranges and bananas.

Vitamin E is of importance to the tissues as a whole. Its deficiency is supposed to cause degeneration to the reproductive organ, and it is, therefore, believed that this vitamin is helpful to the process of reproduction.

Vitamin-H

It is a water-soluble vitamin and this vitamin is identified with "Brotin." - It is mainly found in the liver, kidneys and eggs of all higher animals, and is also widely distributed in vegetables and fruits. It is also present in yeast, grains and nuts. This vitamin cures certain cases of baldness. Its administration is believed to be effective in Psoriasis, a kind of skin disease.

Vitamin-K

There are at least two members in this group—K_1 and K_2. It is a fat-soluble vitamin, and exists in plants and micro-organisms—K_1 in plants and K_2 in micro-organisms. The best sources of this vitamin are Alfalfa, Spinach, Cabbage, Cauliflower, Tomatoes, Strawberries, Sea-weed, Soya bean oil, Wheat germ and Potatoes. Fruits and cereals are generally poor in this vitamin. It is absent in yeast.

This vitamin is necessary for the maintenance of the normal blood coagulation. Pregnant and lactating women need a fair

quantity of this vitamin for the protection of the new bones. It is known as "Philloquinone."

Vitamin-P

It is a water-soluble vitamin and is chiefly present in citrus fruits, *e.g.*, lemons, oranges, pomeloes, and grape-fruits. The skin is generally richer in this vitamin than the juice extracted from the pulp. The lemon juice contains the largest quantity of this vitamin, and then come orange and grape-fruit in order. It is believed to be widely distributed in plants. It is not yet ascertained whether animal materials, *e.g.*, milk, liver or kidneys, contain it.

This vitamin predominantly occurs as glucosides. It is a detoxifying agent. It keeps the walls of capillaries or small blood-vessels in normal healthy condition by maintaining "their elasticity and natural permeability." This vitamin is known as "Citrine" in America and "Hesperidin" in England.

Quantitative Requirements of Vitamins & Standard of Measurement

Vitamins are required in such small quantities that it is difficult to ascertain with any pretension to mathematical accuracy the amounts necessary for our life-processes. However, as a result of various experiments on animals, the scientists have been able to furnish us with some data on which we can work out approximately the quantitative requirements of vitamins. The initial difficulty which stood in the way of working out the figures was the absence of any standard preparations of vitamins. It was found that the same quantity of a certain foodstuff containing a particular vitamin did not always produce equally good results on experimental animals under identical conditions. This was accounted for by the fact that the amount of vitamin content in a foodstuff often varied with the season, climate, soil, storage etc. On the face of such variation, it

was not possible to estimate precisely the actual amount required to produce a certain result. To meet this difficulty, the Health Committee of the League of Nations (now defunct) recommended the adoption of certain standard preparations of a few essential vitamins for measuring their active values quantitatively. These standard preparations not only offer the means of assessing the efficacy of vitamins from the quantitative point of view, but also offer a common measure to estimate the vitamin contents in various foodstuffs. Thus when a certain quantity of a foodstuff produces exactly the same effect on standardised animals that a certain quantity of the standard preparation does, we may take it that the vitamin content of the foodstuff in question is equal to that of the standard preparation used in the experiment. On the basis of such comparative tests, the vitamin contents of various foodstuffs are now numerically expressed in terms of some conventional units of the standard preparations under an International Agreement. By way of illustration, the international unit of ascorbic acid (vitamin C) is 0·05 milligram of the standard preparation or one twentieth of a milligram, and now if it is found by proper test, as indicated above, that a foodstuff of certain quantity contains one milligram of the standard preparation of vitamin C, then in terms of the international unit the value would be expressed as 20 units. At present there exist four international standard preparations covering vitamins A, B, C, and D. The detailed information regarding the international units of these vitamins may be found in any standard book of reference, and for our present study it is enough to bear in mind that these units are now-a-days used in most of the authoritative works to express the vitamin values of foodstuffs instead of the familiar "plus" signs. It is immaterial, however, for all practical purposes whether the vitamin values are expressed in terms of units or "plus" signs, so long we know that a properly mixed diet consisting of both animal

and vegetable foods fairly rich in vitamins, would automatically supply our small requirements.

Table of Vitamin Requirements Per Diem

*Vitamin A ...	... 3 milligrams	or about	4,500 international units.
Vitamin B_1 (Thiamin) ...	1·25 ,,	,, ,,	400 ,, ,,
Vitamin B_2 (Riboflavin)	1·25 ,,		
Nicotinic Acid	... 10·0 ,,		
*Vitamin C (Ascorbic acid)	50 to 80 ,,	,,	1,000 to 1,500 ,, ,,
Vitamin D .	... 6y (microgram)	or	150 to 250 ,, ,,

NOTE :—Additional allowance to be given to children, pregnant women and nursing mothers.

Table of Vitamin Contents of Food

	A	B	C	D
Alfalfa	4	2	4	x
Amarnath leaves ...	4	1	4	x
Amla fruit	x	x	5	x
Apple	Trace	1	1	1
Asparagus	1	3	1	x
Arrowroot	x	x	x	x
Banana	1	2	1	x
Barley	Trace	3	x	x
Beans (French)	1	2	2	x
Beans (Broad)	1	2	2	x
Beef	Trace	2	Trace	x

*Some eminent nutrition workers recommend the increase of Vitamin A by about 50 per cent. and Vitamin C by 100 per cent.

	A	B	C	D
Beetroot	Trace	2	2	x
Betel leaves	4	x	1	x
Brain	2	3	x	1
Bread (wholemeal) ...	x	3	x	x
Bread (white) ...	x	Trace	x	x
Brinjal	Trace	1	1	x
Butter	3	x	x	1
Butter milk	Trace	1	1	x
Cabbage	4	2	3	x
Carrot	4	3	1	x
Cauliflower	1	3	2	x
Celery	4	2	2	x
Cheese	3	Trace	x	x
Chicken	1	1	x	x
Cholam (Juar)	1	2	x	x
Clover	4	3	3	x
Cocoanut	1	2	Trace	x
Cocoanut oil	x	x	x	x
Cocogem	x	x	x	x
Cod liver oil	5	x	x	3
Colocasia	Trace	2	Trace	x
Coriander leaves ...	4	x	4	x
Crab	1	x	x	x
Cream	3	2	1	1
Cucumber	Trace	1	Trace	x
Curds	2	1	Trace	x
Curry leaves	4	x	x	x
Dates	1	1	Trace	x
Drumstick	2	x	3	x
Drumstick leaves ...	4	2	4	x
Egg	3	2	x	2

	A	B	C	D
Egg yolk	4	3	x	2
Fish (fat)	2	2	x	1
Fish (lean)	x	1	x	x
Fish roe	3	2	x	x
Figs	1	Trace	Trace	x
Fenugreek leaves ...	4	2	Trace	x
Garden cress	Trace	1	Trace	x
Garlic	Trace	1	2	x
Gourd (bitter)	1	1	2	x
Gram with husk (Bengal) ...	1	3	x	x
Gram with husk (Green) ...	1	3	x	x
Gram with husk (Red) ...	1	3	x	x
Gram leaves	4	x	x	x
Grape juice	Trace	2	1	x
Grape fruit juice ...	x	2	3	x
Groundnut	Trace	3	x	x
Groundnut oil	Trace	x	x	x
Guava (country) ...	Trace	x	4	x
Halibut oil	5	x	x	3
Heart	4	4	1	1
Honey	Trace	Trace	x	x
Ipomea leaves	4	1	3	x
Jackfruit	2	x	Trace	x
Jaggery	1	x	x	x
Kidney	3	3	1	1
Ladies' fingers	Trace	1	1	x
Lemon juice	x	2	3	x
Lentil	1	3	x	x
Lettuce	3	2	1	x
Lichee	x	1	2	x
Liver	5	4	Trace	x

	A	B	C	D
Maize	1	2	x	x
Mango (ripe)	4	x	1	x
Melon	Trace	x	1	x
Milk (human)	2	1	1	x
Milk (cow)	2	1	1	1
Milk (buffalo)	2	1	1	1
Milk (goat)	2	1	1	1
Milk (skimmed) ...	1	1	1	x
Milk (condensed) ...	2	1	x	1
Millet	Trace	3	x	x
Mint	3	x	x	x
Mustard oil	x	x	x	x
Mutton	Trace	2	x	x
Neem (tender)	4	x	x	x
Oat	1	3	x	x
Onion	Trace	1	2	x
Orange	3	2	3	x
Papya	3	Trace	2	x
Parsnip	1	2	1	x
Pea (fresh)	2	3	3	x
Peach	Trace	x	2	x
Peanut	1	3	x	x
Pears	Trace	1	1	x
Pigeon	1	1	x	x
Pineapples	1	1	3	x
Plums	1	1	1	x
Pomegrante	x	Trace	1	x
Patal	x	1	1	x
Potato	1	2	3	x
Potato (Sweet)	2	2	2	x
Pumpkin	Trace	1	Trace	x

	A	B	C	D
Radish	Trace	1	1	x
Raspberry	x	x	3	x
Ragi (Bajra)	Trace	3	x	x
Raisins	x	1	x	x
Red palm oil	5	x	x	x
Rice bran	1	3	x	x
Rice (milled)	x	Trace	x	x
Rice (home pounded) ...	Trace	2	x	x
Rye	1	2	x	x
Spinach	4	2	3	x
Sago	x	x	x	x
Semolina (Suji) ...	Trace	3	x	x
Shark **liver oil**	**5**	x	x	3
Snake gourd	1	x	Trace	x
Soya bean	2	4	x	x
Strawberry	x	x	3	x
Sugar cane ...	Trace	1	1	x
Sugar	x	x	x	x
Tamarind	Trace	1	Trace	x
Tapioca	x	x	x	x
Tomato (ripe)	4	2	3	x
Turnip . .	1	1	2	x
Walnut	Trace	2	x	x
Water chestnut (Singara)	Trace	x	x	x
Wheat bran	2	3	x	x
Wheat germ . . .	2	4	x	x
Wheat whole	1	3	x	x
White flour	x	Trace	x	x
Yeast	Trace	5	x	x

NOTES :—

1	signifies present		4	,,	very rich
2	,,	moderate	5	,,	exceptionally rich.
3	,,	fairly rich	x	,,	either absent or uncertain.

CHAPTER XII

ACID-ALKALI BALANCE & PROTECTIVE FOODS

Acid-Alkali Balance

We have noted that the normal blood is slightly alkaline in character, and how the maintenance of its alkalinity is essential to our very existence. The process of metabolism produces carbonic acid gas and other wastes which are more or less acid. Although these waste substances are expelled from the body by the excretory organs, there always remains dissolved in the blood a certain quantity of acids, specially the carbonic acid gas. Against this there is the alkaline content of the blood, and these two should exist in a certain ratio for proper functioning of the body. Food undoubtedly plays an important part in maintaining the acid-alkali balance of the blood. It is a curse of the modern civilisation that we have to depend very much upon artificial foodstuffs which are more or less acid-forming, and hence the diseases resulting from the reduced alkalinity of the blood are most common to-day. It is, therefore, necessary that we should supplement our staple foodstuffs by plenty of fruits and vegetables containing mineral salts. But all the minerals are not alkaline. There are some which are alkaline-forming and some which are acid-forming. The most important minerals which deserve mention in this connection are:

Alkaline or Base-forming—Calcium, Magnesium, Sodium, Potassium, Iron and Manganese.

Acid-forming—Phosphorus, Sulphur, Chlorine, Iodine, Fluorine and Arsenic.

It now remains for us to find out the classes of foods which are rich in acid/and alkaline-forming elements respectively. With all

these knowledge we shall be able to a great extent to maintain the acid-alkali balance of the blood by dietetic regulations.

Foods rich in Acid-forming elements—Meat, fish, eggs, oatmeal, pulses, rice, wheat, white bread, etc.

Foods rich in Alkali-forming elements—Apples, lemon, orange, pears, bananas, dates, tomatoes, beet, carrots, radishes, potatoes, sweet potatoes, turnips, water-melon, etc.

It may be interesting to note here that many fruits containing organic acids, particularly the citric acid, are found to produce alkaline reaction in the long run. Whether they are potentially acid or basic depends upon the extent to which the acids are oxidised in the body, forming alkaline salts. Thus tomatoes, oranges, pears, pineapples are all said to have an alkaline reaction. Many dietetic experts are of opinion that even some of the fruits containing malic and tartariç acids, such as apples and grapes, are also potentially alkaline in reaction.

In this connection, it would be appropriate to make a brief reference to two other acids, *viz.*, uric acid and oxalic acid. These two acids are distinctly acid-forming and are the most common causes of the acidity of our blood. In order to maintain the acid-alkali balance, we must avoid taking too much of those food-stuffs which are the principal sources of these acids.

Uric Acid

The normal end-product of the combustion of protein is urea which is passed out in urine. It is the last stage in the metabolic process of the nitrogenous food-stuffs. Uric acid is also in a sense an end-product of some protein metabolism. It is poisonous and cannot be expelled by the kidneys freely. The chief points at which it accumulates are several joints of the body, causing a very painful disease called Gout. It may also form deposits in kidneys or bladder,

causing the production of stone. In order to keep the blood in a healthy condition, the excessive intake of such highly nitrogenous food-stuffs as meat, fish, pulses, should be avoided. It is believed that gout and diseases of like nature present among the Indians is due to the extreme popularity of pulse as a food-stuff.

Oxalic Acid

Oxalic acid is produced mainly by (1) regular consumption of refined foods, such as white sugar, white flour, etc., (2) by fermentation due to hurried eating, and consumption of too much fried food. Oxalic acid is also prevalent to an excessive degree in some vegetable foods, specially in Spinach.

Foods Free from Uric Acid

In view of what has been said about the danger of the accumulation of the Uric acid, it is important to bear in mind the common foods which are Uric acid-free for our guidance. These are as follows :

(1) Milk and its products, such as curds, sour milk, cheese, etc.

(2) Breadstuffs and cereals.

(3) Nuts.

(4) Vegetables in general, both leafy and root.

(5) Garden fruits like apples, black-berries, oranges, lemons, mangoes, jack-fruit, etc.

(6) Dried fruits, such as figs, almonds, walnuts, grapes, raisins.

What are Protective Foods

In the course of our discussion we have had occasions to use the term "protective" in relation to some elements of food. The term is particularly used in relation to those foods which are rich sources of important mineral salts and vitamins. It is also now

applied to those foods which possess what is called "good" proteins, so essential to body-building. We have found how indispensable are vitamins to proper utilisation of various food elements in the human body, and how they afford protection against various deficiency diseases like Beri-Beri, Rickets, Pellagra, Scurvy etc. We have also noted what an important part the mineral salts like Calcium, Phosphorus, Iron etc., play in our life processes. Obviously, therefore, the protective foods are those which contribute most efficiently to body-building, particularly at the initial stage of development, and also to maintenance of health and vigour by warding off deficiency diseases.

In the light of the above facts, the following articles fall in the category of "protective foods" :—

"Milk with its products, eggs, the glandular animal tissues, such as liver, heart, kidneys, lungs, "fat" fish, leafy vegetables, and fresh fruits. Fats like butter and cod-liver oil are also of special values."

A survey of the annexed table will furnish us with valuable information as to the relative values of food-stuffs from the "protective" point of view. The figures are taken from the report of the Health Committee of the League of Nations (now defunct).

Table of Relative Protective Values of Foodstuffs

Food-stuffs practically non-protective:—

	Protein	Minerals	Vitamins A	B	C	D
Cereals—Rice and Bread (white and polished) . .			—	—	—	—
Sugar, Jam, Honey ...			—	—	—	—
Margarine, Olive oil, and other vegetable oils ...			—	—	—	—

Food-stuffs highly protective :—

	"Good" Protein	Minerals	Vitamins A	B	C	D
Milk ...	2	3	1	1	1Q	1Q
Cheese ...	2	2	1	1	—	—
Eggs ...	2	2	1	2	—	2
Liver ...	2	2	1	2	—	1
"Fat" fish (Herring etc.) ...	1		1	1	—	2
Salads (Green vegetables) ...	1	3	1	1	2	—
Raw fruits, fruit juice ...	—	3	1*	1	2	—
Butter ...	—	—	1	—	—	1Q
Cod-liver oil ...			3	—	—	3
Yeast ...	1	1	—	2	—	—

Food-stuffs more or less protective:—

	"Good" Protein	Minerals	Vitamins A	B	C	D
Meat ...	1	T	—	1	T	—
Root vegetables (Tubers) ...			1*	1	1	—
Legumes (Dry peas, pulses) ...			—	1	—	—
Cereals, Bread (whole meal) ...	1	T	T	1	—	—
Nuts ...	T		—	2	—	—

NOTES :—

3 signifies very rich
2 ,, rich
1 ,, present
T ,, traces
— ,, absent
Q signifies summer, when cows are on pasture
* signifies if yellow in colour.

CHAPTER XIII

PLANNING OF DIETARIES

How to Determine the Standard Diet

We are now familiar with all the food constituents which are essential to proper nutrition of our body. We have seen that the three principal constituents of food are Proteins, Fats and Carbohydrates, and if we can now ascertain the quantity of each of these three elements required for the maintenance of life, we shall be in a position to prepare dietaries consistent with our requirements, provided that we know the various proportions in which these elements are distributed in food-stuffs. This does not mean, however, that we are relegating the two other essential elements *viz.*, vitamins and mineral salts, to the background. Rather these two vital elements will remain in the forefront as constant factors in any dietetic scheme worth the name. The main object of this chapter is only to ascertain how much each of the other three elements which form the bulk of our diet, is necessary to proper nutrition. Once these figures are established, the task of constructing dietaries in the light of all the five elements taken together, will be much easier. Now to return to the main point of our present discussion. As a result of laboratory works, the composition of all the principal food-stuffs has been determined with a certain amount of accuracy, the details of which are embodied in Appendix I. The first and the most difficult question which confronts us at this stage is how to ascertain at least approximately the quantity of each constituent an average person requires for his bodily function. This will lead us to explore a complicated field of enquiries and experiments which have been made from time to time by various scientific observers. It is well to recapitulate here some of the facts which we have found in the course of previous study. We remember that in order to enable

our body to function properly, we require both nitrogenous and carbonaceous foods, the former for building and repairing the body and the latter for providing the necessary heat and energy. We have seen that the waste of the nitrogenous substance is passed out of the body mainly through the kidneys and to some extent through the skin, in the form of urea dissolved in water, and that of the carbonaceous substance mainly through the lungs in the form of carbonic acid gas mixed with water. We have also seen that the urea consists of carbon, hydrogen, oxygen and nitrogen; carbonic acid gas of carbon and oxygen; water of hydrogen and oxygen. Thus the wastes which are expelled from our body, mainly consist of oxygen, hydrogen, carbon and nitrogen. Naturally we want to restore to the body the same quantity of each of these elements that is lost, in order to maintain the equilibrium of our body. We obtain plenty of supply of oxygen through our lungs, both oxygen and hydrogen with the water we drink and also with the food-stuffs, most of which contain very large percentages of water. Thus the loss of these two elements, *i.e.*, oxygen and hydrogen, is made up practically without much effort. But the question of the restoration of the other two elements, *i.e.*, carbon and nitrogen, in proper quantities, presents some difficulty and requires investigation.

Now, first of all we have to ascertain the quantity of each of these two elements daily passed out of the body, and for this purpose a series of experiments have been made upon persons in different circumstances, such as persons living on starvation or bare subsistence diet, persons doing no work, persons doing a fair amount of work, and persons doing hard work. By the close observations of the diets of these persons and also the quantities of nitrogen and carbon expelled from the body in each case, the scientists have furnished us with a number of facts and figures on the basis of which we can determine what constitutes minimum diet, standard diet, and also diet for hard work. With these figures as our guide,

we find that an average person doing a fair amount of work daily expels from his body 300 grains of nitrogen and 4800 grains of carbon in round figures, and the loss of carbon increases with the increase of work, while that of nitrogen remains more or less constant.

What is a Standard Diet

We have just seen that an average person doing a fair amount of work daily expels from his body 300 grains of nitrogen and 4800 grains of carbon, and, therefore, the primary condition of a standard diet is that it must replenish the exact loss of these two elements. It should be remembered here that the individual elements are of no use to the body as food unless they are taken in forms as present in complex substances. Such complex substances are proteins, fats and carbohydrates besides other constitutents of food. Now the question arises, what constitutes a standard diet in terms of proteins, fats and carbohydrates *i.e.,* how much each of these constituents should form part of a standard diet, furnishing 300 grains of nitrogen and 4800 grains of carbon. There is a certain amount of controversy among the Physiologists regarding the quantities of the different constituents required by a standard diet. Without entering into details of this controversy, we may take the figures recommended by the British Ministry of Health as the basis of our present study.
These are as follows :

Protein ...	... 100	grammes	or	3·55 ozs.
Fat ...	... 100	,,	or	3·55 ozs.
Carbohydrate	... 400	,,	or	14·20 ozs.

Besides these, a certain quantity of mineral salts and vitamins is necessary. Taking the amount of mineral salts to be in the neighbourhood of 30 grammes or a little over 1 oz., the total quantity

of elements in a standard diet comes to about 23 ozs., (small quantity of vitamin being negligible in the total weight). It must be remembered that the figures given in this table are free of water. Taking our foodstuffs to contain 50 percent of water on an average, the total quantity comes to about 46 ozs. This diet, when calculated in terms of nitrogen and carbon, has been ascertained to furnish each of these elements in a quantity which is approximate to our basic figures *i.e.,* 300 grains of nitrogen and 4800 grains of carbon.

Energy Value of Standard Diet

It has been noted that the two main functions of food are to provide materials for body building and also energy to do work. A standard diet necessarily fulfils both the functions. We are already familiar with the different constituents of a standard diet, but our knowledge will be far from complete so long we cannot find out its energy value *i.e.,* how many calories are provided by a standard diet. When this figure is obtained we can at once say that an average adult doing a fair amount of work, requires so many calories. We have already found how by means of burning a certain quantity of food in the Calorimeter its heat value together with its energy-yielding capacity can be determined. Not only this. The amounts of heat generated in the body by the combustion of one gramme of protein, one gramme of fat and one gramme of carbohydrate respectively, have also been ascertained by experiments :

Thus the combustion of 1 gramme of	protein	gives	4·1 calories.
,, ,, ,, ,,	fat	,,	9·3 ,,
,, ,, ,, ,,	carbohydrate	,,	4·1 ,,

Now, if we only know the percentage composition of an article of diet we can easily find out its caloric value. Let us take a hypothetical case by way of illustration. Suppose an article of diet contains 2 per cent protein, 3 per cent fat, and 4 per cent carbo-

hydrate. To simplify the calculation, let us take the quantity of the foodstuff as 100 grammes. Thus we obtain from this foodstuff 2 grammes of protein, 3 grammes of fat, and 4 grammes of carbohydrate. Now by referring to the above table we can find out the caloric value of the 100 grammes under enquiry by simple multiplication.

Let us now proceed to find out the caloric value of a standard diet. The matter is a simple one. If one gramme each of protein and carbohydrate is equivalent to 4·1 calories, and one gram of fat represents 9·3 calories, then how many calories represent the standard diet consisting of 100 grammes of protein, 100 grammes of fat, and 400 grammes of carbohydrate? The results are as follows :—

	Grammes.	Calories.
Protein	$100 \times 4{\cdot}1$	410
Fat	$100 \times 9{\cdot}3$	930
Carbohydrate	$400 \times 4{\cdot}1$	1640
	TOTAL	2,980

Thus the caloric value of the standard diet comes to 3,000 calories in round figure.

By way of further illustration, let us assume that a certain food-stuff contains 2 per cent protein, 3 per cent fat, and 4 per cent carbohydrate. Now in 100 ozs. of this food-stuff we obtain 2 ozs. of protein, 3 ozs. of fat, and 4 ozs. of carbohydrate, which are equivalent to :—

Approximately 57 grammes of	protein	$(2 \times 28{\cdot}3)$	28·3 grams make 1 oz.
,, 85 ,,	fat	$(3 \times 28{\cdot}3)$	
,, 113 ,,	carbohydrate	$(4 \times 28{\cdot}3)$	

Proceeding further				Calories.
57 grammes of	protein	give	228	(57 × 4·1)
85 ,,	fat	,,	776	(85 × 9·3)
113 ,,	carbohydrate	,,	452	(113 × 4·1)
		TOTAL	1,456 calories	

Thus 100 ozs. of the food-stuff under enquiry give 1456 calories.

In the light of the above facts, we can find out the caloric value of any quantity of food-stuffs by referring to the tables of composition of the articles of diet.

Factors Causing Variations in Calorie Requirements

We have now found out that a standard diet contains about 3000 calories. In estimating the number of calories required by a person, most of the western physiologists have taken an adult of the average body weight of 70 kilograms (154 lbs.) doing a fair amount of work, as their basis. The Nutrition Committee of the League of Nations considers that an average adult living an ordinary life in a temperate climate and not engaged in manual work, requires 2400 calories net per day after deducting wastes in cooking and at table, *i.e.,* 100 calories per hour in a day. Of course, the additional calories must be allowed according to the muscular activity of a person, and the following table furnished by the Committee will throw light on the matter :—

Light work	...	up to 75 calories	per hour	of work.
Moderate work	...	,, 75-150 ,,	,,	,,
Hard work	...	,, 150-300 ,,	,,	,,
Very hard work	...	,, 300 and upwards	,,	,,

The calorie requirements for other ages than adult and for mothers are furnished by the following table :—

Age		*Calories per day.*
1— 2	...	840
2— 3	...	1000
3— 5	...	1200
5— 7	...	1400
7— 9	...	1680
9—11	...	1920
11—12	...	2160
12—15	...	2400
15 and upwards	...	2400

Women :—

Age			*Calories per day.*
Expectant	...	...	2400
Nursing	...	...	3000

Babies :—

	Calories per kilogramme of body weight.
0— 6 months	100
0—12 ,,	90

It should be remembered that the growth of a child is very rapid during the suckling period, and hence it requires comparatively larger calories per kilogramme of body weight at this period than at any other age. With its growth, its allowance of food has naturally to be increased but with diminished calories per kilogramme of body weight, as the rate of growth decreases with age. The following table furnished by Mendel indicates the relative daily gain in body weight of children :—

In the first month about	...	...	1·00 per cent.
At the middle of the first year		...	0·30 ,, ,,
At the end of the first year	...	...	0·15 ,, ,,
At the fifth year	...	...	0·03 ,, ,,

Maximum in later years :-

for boys	...	0·07 per cent.
for girls	...	0·04 ,, ,,

In studying the calorie requirements, it should be borne in mind that the average weight of an Indian is much less than that of a European. Besides, the climate of India is much warmer than that of Europe. Naturally, therefore, an average Indian should be allowed fewer number of calories than an average European or American.

CHAPTER XIV

HOW TO ESTIMATE THE RELATIVE VALUES OF FOODSTUFFS

From the foregoing study, we may conclude that in the construction of dietaries it is at first necessary to take stock of the constituents of our foodstuffs, and then see how far they fulfil our needs both from the calorific and body-building points of view. It is well to remember here that we require both nitrogenous and carbonaceous foods in a certain proportion for the harmonious working of our body machnie. Now, there are certain foods which contain almost exclusively carbohydrates and/or fats. They will certainly provide us with energy for doing work but no material for building our body. On the other hand, there are foods which contain a large percentage of nitrogenous substance with very little carbohydrates or fats. While these foods will provide us with material for building our body, they cannot provide us with the necessary energy for doing work. Then there are foods containing fair percentages of both the energy-yielding and building

materials. All these facts have to be borne in mind when making proper valuation of a foodstuff, and the total amount of the nutritive material contained in it cannot be the sole test. We have to consider primarily what kind of nutritive material it is and what purpose it serves. Does it only provide for energy or for building or for both? Then we have to consider how much of the energy-yielding material consists of fats and how much of carbohydrates, in view of the fact that fats give more than twice as much energy as carbohydrates. Lastly, we have to consider whether the body-building material consists of animal or vegetable proteins, as it has been found that the animal protein is generally more valuable than the vegetable protein. By way of clarifying the points discussed here, let us now make a comparative study of some food-stuffs.

Sago

It consists of about 87 per cent starch with practically no protein or fat. The only nutritive element present here is a high percentage of carbohydrate which only provides for energy. There is absolutely no building material in it. Although its caloric value is very high, it is of no use as far as body-building is concerned. Therefore, it is fallacious to give it a high place among the nutritive foods, although it contains as high as 87 per cent nutritive material.

Wheat

It contains about 72 per cent starch, 1·5 per cent fat and 11·5 per cent protein. The total nutritive material here is 85 per cent, a little less than Sago. But it is considered a much more valuable food-stuff than sago, though possessing less caloric value because it contains both body-building and energy-yielding materials.

Oat-Meal

It roughly consists of 63 per cent starch and sugar, 8 per cent fat, 14 per cent protein. The total nutritive material here comes to about 85 per cent, containing all the important food constituents—protein, carbohydrate and fat. Thus not only from the point of percentage of the total nutritive material but also from other points, it ranks very high among the foodstuffs. It provides materials both for energy and body-building. Although it contains only 71 per cent of energy-yielding material (63 per cent carbohydrates and 8 per cent fat) as against about 74 per cent in wheat, its caloric value is much higher than that of wheat due to its high fat content—fats yielding more than double the energy of carbohydrates.

Chicken

It contains about 22 per cent protein and 3 per cent fat. The total nutritive material found here is only 25 per cent as against 87 per cent in sago. From the caloric point of view it has hardly any value but as far as body-building is concerned, it has a value of its own. It is a nitrogenous food, and any comparison between the nitrogenous and the non-nitrogenous foods will lead us to no practical results. Each has a value of its own, from the point of nutrition. Therefore, in estimating the relative values of foodstuffs, a line of demarcation should be drawn between the nitrogenous and non-nitrogenous foods, and comparisons should generally be made in the light of this fact, *i.e.*, between foods in the same category.

Pulse—Mushur Dal

It approximately consists of 25 per cent protein, 60 per cent carbohydrate, 1 per cent fat. Although it has a large percentage of carbohydrate, it is classified among the nitrogenous foodstuffs containing, as it does, a very high percentage of protein. The

percentage of its nitrogenous substance is 25 as against 22 in the chicken, and in the ordinary course, it should rank higher than the other one in the group of nitrogenous foodstuffs. But we must remember that the animal protein is superior to the vegetable protein, and, therefore, the chicken, though containing less protein than pulses, is considered to rank higher than the latter in the group of nitrogenous foods. It must be noted, however, that the Lentil (mushur dal) contains 60 per cent energy-yielding material as against only 3 per cent in the other. Thus in respect of the total amount of nutritive material, the Lentil comes first and then the Chicken.

The illustrations given above furnish us with some clues as to the way of roughly estimating the relative values of foodstuffs. Now it remains for us to consider the factors which ultimately determine the intrinsic values of foods.

How the Values of Food-stuffs are influenced by their Digestibility and Assimilability

We know that there are several foodstuffs which contain approximately an equal percentage of one or the other nutritive element or of all the nutritive elements taken together. Ordinarily their nutritive values should be identical but actually they are not found to be so in most of the cases. Even a foodstuff containing a higher percentage of a particular nutritive element may give less nourishment than the one containing a lower percentage of the identical element. How to explain this anomaly? We can say from our practical experience that foodstuffs even of the same nature require different times for digestion. Naturally the foodstuff which requires a longer time for digestion, involves the expenditure of extra energy, and this loss of energy must be deducted from the total nutritive value of that foodstuff. Therefore, the foodstuff even with comparatively less nutritive element may be more profi-

table to the body because it is readily digested, and does not cause any unnecessary waste of energy, as in the previous case.

Further, it has been found by experiments that the nutritive material of practically all the foodstuffs is not wholly available to the body. Only a certain portion of it is extracted, and the rest is cast off as waste—the proportion of waste varying in different foodstuffs, or to use the techinical expression, the co-efficients of the digestibility of fodstuffs are variable. Again, even the extracted portion properly digested, is not wholly assimilated, and here also the proportion of waste differs in different foodstuffs. The superiority of the animal proteins over the vegetable ones, as has been already noticed in our previous study, is an illustration in point. Not only the percentage of proteins extracted from animal foods is higher than that extracted from vegetable foods, but also the percentage actually built into the tissues, is higher in the case of animal proteins than in the case of vegetable proteins. In other words, the animal proteins are biologically superior to the vegetable proteins.

All these considerations prove beyond doubt that the nutritive values of foodstuffs are very much modified by their digestibility and assimilability.

The annexed three tables indicating in order, the times taken in digestion of some common foodstuffs, the co-efficients of the digestibility of some foods, and the bioligical values of a few nitrogenous foods, will be an illuminating study.

TABLE NO. 1

Name of food	Time of digestion (Stomach)
Eggs (Raw)	2 hours
Eggs (Light boiled)	3 ,,
Eggs (Hard boiled)	3 ,, 30 minutes

Name of food	Time of digestion (Stomach)
Milk (Raw)	2 hours 15 minutes
Milk (boiled)	2 ,,
Fowls (Roasted)	4 ,,
Chicken (Boiled)	2 ,, 45 ,,
Mutton (Roasted)	3 ,, 15 ,,
Mutton (Boiled)	3 ,,
Beef (Boiled)	2 ,, 45 ,,
Beef (Roasted)	3 ,, 30 ,,
Cheese	3 ,, 30 ,,
Butter	3 ,, 30 ,,
Rice	1 ,,
Sago	1 ,, 45 ,,
Barley	2 ,,
Corn cake	3 ,,
Corn bread	3 ,, 15 ,,
Wheat bread	3 ,, 30 ,,
Potatoes (Roasted)	2 ,, 30 ,,
Potatoes (Boiled)	3 ,, 30 ,,
Apples	1 ,, 30 ,,
Beans	2 ,, 30 ,,
Cabbage	4 ,,
Parsnips	2 ,, 30 ,,
Carrot	3 ,, 15 ,,
Turnips	3 ,, 30 ,,
Beets	3 ,, 45 ,,
Tapioca	2 ,,
Chicken soup	3 ,,
Mutton soup	3 ,, 30 ,,
Marrow bone soup	4 ,, 15 ,,
Barley soup	1½ ,,
Bean soup	3 ,,

NOTES.—The times given in this table should by no means be taken as absolute. They, however, provide a valuable guide for estimating approximately the relative digestibility of some common foodstuffs subject to the various conditions under which they are eaten.

It will be noted from this table that liquid foods are not necessarily more easily digested than solid foods. It is, however, believed that the fatigue caused by illness is more quickly relieved by liquid than solid nourishment.

TABLE II

(Co-efficients of digestibility of foods)

	Protein	Fat	Carbohydrate
Animal foods ...	97 per cent	95 per cent	98 per cent
Cereals and Breadstuffs ...	85 ”	90 ”	98 ”
Dried Legumes ...	78 ”	90 ”	97 ”
Vegetables ...	83 ”	90 ”	95 ”
Fruits ...	85 ”	90 ”	90 ”
Total food of average mixed diet ...	92 ”	95 ”	98 ”

NOTES:—This table is furnished by Atwater. It will be noted from this table that as far as protein foods are concerned, not only the percentage of digestion of proteins is much higher in the case of animal foods than in the case of vegetables, but also, on the whole, the animal foods comparatively furnish a larger percentage of the existing nutrients to the body than the vegetable foods like pulses, peas, beans, etc.

TABLE III

(Table showing the biological value of the proteins in certain foods)

Food-stuffs	Biological value
Barley	71
Cambu	83
Cholam	83

Food-stuffs	Biological value
Italian millet	77
Maize, tender	60
Oatmeal	65
Ragi	89
Rice, raw, polished	80
Wheat, whole	67
Bengal gram	76
Black gram	64
Cow pea	61
Green gram	51
Horse gram	59
Lentil	41
Red gram	74
Soya bean	54
Amarnath leaves	72
Cabbage leaves	76
Drumstick leaves	41
Ipomea leaves	67
Sesbania leaves	64
Potato	67
Sweet potato	72
Brinjal	71
Cluster beans	51
Ladies fingers	82
Cashewnut	72
Cocoanut	58
Gingelly seeds	67
Linseed	78
Groundnut, raw	58

Food-stuffs	Biological value
Groundnut, roasted	50
Beef, liver	77
Beef, muscle	98
Egg	94
Milk, cow's	85

NOTE:—The table is taken from Health Bulletin No. 23 published by the Government of India.

CHAPTER XV

FUNDAMENTALS OF A PROPER DIET

Necessity of Mixed Diet

It has been noted that amongst the three major constituents of food, *i.e.* protein, carbohydrate and fat, only the protein provides us with all the four elements, *viz.*, hydrogen, oxygen, carbon and nitrogen, necessary to the proper nutrition of the body. Naturally the question here arises, can we then depend for our nutrition on protein foods only? We remember that the standard diet should consist of 300 grains of nitrogen and 4800 grains of carbon approximately—the proportion being 1 to 16. Now if there were any nitrogenous food with nitrogen and carbon in the above proportion, the problem of diet would be more than simplified. But as a matter of fact, there is no foodstuff which contains these elements exactly in this proportion, and, therefore, no single article of food can provide both the elements in right amounts. One or the other element is bound to be either too much or too little in the diet with adverse effects on nutrition. There are other factors too, which require consideration. The intake of the same sort of food day after day will prove nauseating, causing numerous

complaints like loss of appetite, indigestion, diarrhœa, etc. It should also be remembered that the proteins of pulses, cereals etc. which are inferior to those of milk, eggs, meat and fish, are better assimilated when the diet consists of various types of proteins. Besides, the proteins so mixed are naturally cheaper than any exclusive animal protein. All the above facts suggest the advisability of depending upon a mixed diet, which affords us sufficient scope not only to take the two elements in question (nitrogen and carbon) in due proportion without unnecessarily burdening the digestive organs, but also those important "protective" elements of food, *viz.*, vitamins and minerals, which lie scattered among different foodstuffs in varying quantities.

To clarify the matter, let us examine one or two representative foodstuffs. Rice is a staple food for millions of people. If we bear in mind its composition (approximately 7 per cent protein, 78 per cent carbohydrate) and also the caloric value of one gram of carbohydrate (4·1 calorie), we can find by simple arithmetic that the necessary calories (2400 to 3000) could be obtained from about 2 lbs. of rice. The first question here arises whether it is possible for an average man to eat as much as 2 lbs. Even if it were possible, the next question which requires examination is whether he would be obtaining the necessary amount of protein required by a balanced diet *i.e.*, 80 to 100 grammes. Now rice contain only 7 per cent protein, and, on this basis, 2 lbs. of rice can yield at best 2 ozs., or nearly 57 grammes of protein. Even this amount of protein is not wholly available to the body when examined in the light of the co-efficient of the digestibility of the protein of rice and its biological value. Deducting all these wastages, one cannot expect even half the amount of protein necessary for proper nutrition, from 2 lbs. of rice. It may be argued that Atta (whole wheat) containing, as it does, a much higher percentage of protein, may fulfil the requirements of a

complete diet, as apparently 2 lbs. of Atta will almost yield the necessary amount of protein as well as the required number of calories. But the same initial difficulty arises here, as in the case of rice, and that is, an average person can hardly take Atta in such bulk. Then the biological value of the protein of wheat being much lower than that of rice, the actual amount of protein ultimately available to the body does not much improve our position. Last but not least, comes the question of vitamins and minerals which are so indispensable to the vital processes of the body. Neither Rice nor Atta can give all the necessary vitamins and minerals. These foodstuffs must, therefore, be supplemented by other edible articles like milk, fish, meat, eggs, pulse, vegetables and fruits, so mixed and in such quantity as to furnish all the elements of food in right proportions without unnecesarily taxing the digestive apparatus.

Even milk which contains all the elements of food including important vitamins and minerals, is not capable of giving proper nutrition to an average adult. It contains a high proportion of proteins in relation to energy-yielding substances, and while about 6 lbs. of cow's milk will give an average person the necessary amount of protein, it is not enough to provide the necessary number of calories. By referring to the composition of milk, one will find that no less than 12 lbs. can furnish the adequate number of calories, but this would involve a man's taking about double the quantity of protein required by him. Besides this, an exclusive milk diet cannot keep a person fit for a long time, since milk lacks some important mineral elements like iron, iodine etc., which must be obtained from other sources, and also it involves ingestion of too much water which is likely to interfere with the digestive process.

Thus considering the problem from all different angles, it can be said that only a diet consisting of an intelligent combination of various foodstuffs can give us adequate nourishment.

What is an Optimum Diet

The physiologists in the past often used to measure the standard diet in terms of the minimum diet required by an adult, which just keeps the human machine going. Present-day physiologists, however, take their stand on a more scientific basis, and have developed the idea of an optimum diet which will enable the body to perform its functions most efficiently, ensuring the harmonious development of all the tissues and organs, and power of resistance to disease. That is, an optimum diet will not only ensure proper functioning of the human machine, but also give that positive and abundant health which is needed to fight the battle of life. This implies that in an optimum diet all the constituents of food should be so mixed and in such proportions that "it cannot be improved by increasing or decreasing any of its constituents." Such a diet may be considered from two points of view:

(1) *Quantitative*—which deals with protein, carbohydrate and fat requirements.

(2) *Qualitative*—which deals with "good" protein, mineral and vitamin requirements.

In preparing an optimum diet both the aspects have to be carefully considered, and it will be seen in our later study that a properly mixed diet quantitatively optimum generally assures an optimum from the qualitative point of view too.

What is a Balanced Diet

From our previous study we have found how the different elements of food are inter-dependent, and how one cannot function properly without the other. Not only this. Each of these elements must exist in the diet in a certain definite proportion for their proper utilisation in the body as a whole. Excess or deficiency of any of them is bound to interfere with the metabolism of one or

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the other element. We may remember that it is the mixed diet which is capable of providing us with different elements of food in right proportions, and when a mixed diet consists of a variety of food-stuffs, furnishing each of the elements of food not only in right quantity but also in right quality, it is called a balanced diet. A diet which is well-balanced is necessarily an optimum diet. It must be remembered that in a well-balanced diet at least one-half of each of the protein and fat should be of animal origin. If we now refer back to our previous discussions about the amounts of food elements required by a normal adult for maintenance of health, a well-balanced diet should approximately contain 100 grammes of protein, 80 grammes of fat and 400 grammes of carbohydrate with proteins and fats derived from both animal and vegetable kingdoms, and liberal amounts of "protective" foods consisting of mineral salts and vitamins, mainly derived from dairy products, green vegetables and fruits.

What is Malnutrition

With the development of the science of nutrition, the term "Malnutrition" has come to gain a wide currency. The term is often mixed up with under-nutrition or undernourishment. Undernutrition means insufficiency of food both from the quantitative and qualitative points of view *i.e.* food deficient both in calories and "protective" elements. Malnutrition generally implies wrong type of food which may be sufficient, even more than sufficient in quantity, but deficient in quality. Prolonged intake of food deficient quantitatively and/or qualitatively, brings about a condition of ill-health, in respect of which the term "Malnutrition" is particularly used. As under-nutrition ultimately leads to malnutrition, the relationship between the two terms, practically speaking, is one of cause and effect.

Malnutrition is indicated by a variety of unhealthy symptoms, both physical and mental—diminished vitality, low power of resistance, reduced capacity for work, apathy, inertia, stagnation etc. Though malnutrition cannot be called actual disease, it produces conditions which prove to be worse than disease itself. With the general deterioration of health, a person becomes unfit to perform the normal duties of life in an efficient manner, and what is worse is that he is liable to fall an easy prey to diseases. Deficiency diseases, and many diseases of infectious nature are the direct results of malnutrition. Malnutrition is very much in evidence among the masses in India, whose diets show an all-round deficiency, particularly in regard to "protective" foods. Infants, children and mothers who are the most vulnerable elements in a community, are its chief victims.

CHAPTER XVI

THE PROBLEM OF DIET

Despite all the knowledge we have so far acquired in the matter of diet, there yet remains for us to study some facts, which are essential to the construction of proper dietaries. The standard diet only covers the requirements of an average adult doing a fair amount of work. Even here the amount and nature of the diet require modifications to suit individual tastes, habits and other peculiarities. There is a lot of truth in the statement that in the matter of diet "each individual is a law unto himself", inspite of the fact that there are certain foods which are considered safe for all. Apart from this personal factor, there are other factors too, such as age, sex, occupation, climate etc.

which obviously necessitate variations in diet to a considerable extent. Let us now examine the dietetic needs varying according to these factors, always bearing in mind that even within a particular category all men are not alike, and a bill of fare cannot be so devised as to be equally suitable for all. However, the undermentioned discussions will provide us with clues as to how we should construct dietaries to suit different conditions.

Diet for Children

It has been already said that the children require comparatively a larger proportion of nitrogenous food than the adult per unit of body weight, as a growing person needs protein not only for repairing but also for building up the tissues, while a fully grown up person needs it only for repairing purpose. It should also be remembered that during the suckling period the growth is more rapid than at any other age, and, therefore, the necessity of a predominantly nitrogenous diet becomes all the more imperative in the case of an infant. A high proportion of nitrogen content in human milk is a distinct pointer, and, therefore, it is wrong to overburden the children with excessive starch, sugar or fat. As has been already noted, a child with a large proportion of starch in his diet generally becomes flabby with bones so soft as to yield to the slightest pressure. Usually a child should not be given starch before it has reached the 7th month, as the salivary secretion which aids the digestion of starch, is deficient before teething. During the whole period of its growth, special care should be taken to provide it with a liberal share of "protective foods" particularly rich in vitamins A, C and D, and also iron. It is, therefore, necessary that even during breast-feeding a child should sometime have a supplement of fresh fruit and green vegetable juices to ensure the adequate intake of vitamins A and C and also iron. In absence of sufficient sun-shine, provision may

be made for a small dose of cod-liver oil in some digestible form for vitamin D.

At the end of the suckling period, the main diet of a child should consist of cow's milk which not only furnishes it with an adequate supply of protein in an efficient form, but also the essential mineral salts and vitamins. But the milk should not contain excessive fat, as a large amount of fat interferes with digestion. Milk containing 3 to 3·5 per cent of fat is most suitable for an infant. The milk of an Indian cow is generally rich in fat—its fat content being considered to be a little higher than that of a Western cow. It is, therefore, necessary that the milk should be properly diluted to suit the digestive apparatus of the child. In addition to cow's milk, the child should be given such starchy foods as are most easily digested, *e.g.*, Rice, potatoes, sago, barley, arrowroot, suitably prepared. 'Protective foods' rich in minerals and vitamins should be continued in the diet but not to be greatly increased, as the rate of the growth of the child decreases with age.

In this connection, it may be mentioned that a child requires a small amount of food at one time, but more frequently than an adult, in order to have its full quota. Whenever a child refuses feeding, it should be allowed to have its own way. "Mother Nature is a very peculiar Dame, and often takes this means for safeguarding her children."

The following rules should be remembered in feeding an infant.

(1) Protein—1½ ozs. of cow's milk per lb. of the weight of a child will secure the protein requirement.

(2) ⅛ oz. of sugar per lb. of body weight is more than sufficient.

(3) Milk will supply the necessary amount of fat and no additional fat is necessary.

(4) The bone-forming minerals, calcium and phosphorus, will be obtained from the adequate quantity of milk.

(5) $2\frac{1}{2}$ ozs. of fluid per lb. of body weight are necessary to proper nutrition. Milk will provide the bulk, and the deficiency should be made up with water.

(6)) If necessary, orange juice may be given even as early as from the third month to make up the deficiency, if any, of vitamins and minerals in the mother's milk. The fruit juice makes up the deficiency of calcium which is partially lost from milk in the course of boiling. In the absence of bright sunshine, one or two spoons of cod-liver oil will supply vitamin D, preventing the incidence of rickets.

(7) From about the 6th month a small quantity of vegetable juice should be given, particularly for iron.

(8) From about the 7th or 8th month starchy foods may be added to the diet but in small amounts. The daily intake of milk should be in the neighbourhood of 20 ozs.

The following figures representing approximately the daily calorie requirements of average infants at various ages in India, will repay study. It should be remembered that an infant with more than average weight and vigour necessarily requires more calories than an average infant of the same age.

					Calories.
1st.	week	...	...	...	200
1st.	month	...	...	...	240
2nd.	,,	...	...	...	400
3rd.	,,	...	...	...	450
5th.	,,	...	...	...	600
8th.	,,	...	...	...	700
12th.	,,	...	...	...	800

Human milk yields about 20 calories per ounce, and the daily secretion from the breast is in the neighbourhood of 30 ozs. These facts read with the above figures suggest that an infant should have additional calories from some other source soon after the 5th month.

Diet for the Aged

There is a good deal of truth in the remark that the aged people should be considered as "damaged goods". During old age all the organs become enfeebled, with the process of metabolism becoming slower. There is weaker digestion and less appetite, and this necessitates consumption of less food, and such kinds of food that admit of easy digestion. Excessive protein is not properly digested, but is susceptible to putrefaction. On the whole, in the dietary of the aged there should be an all-round diminution of the major food elements, *viz.*, protein, carbohydrate and fat.

The teeth of men and animals generally indicate the type of food they should take, and in this respect the old and the children are almost on the same footing. Therefore, the diet of old age should approximate to that of childhood, with the difference that in the case of a child the constructive side of the diet is of first importance, while in the case of the aged the preventive aspect of the problem should receive most attention. Like children, the old people also require small amounts of food at one time, eating more often than the average adult. Highly "protective" foods like milk and its products, fruits, and leafy vegetable juice, should form the main bulk of their diet.

Even long before reaching the old age, a man should start making modifications in his diet. As soon as he reaches the middle age, say at 40, he should make a close scrutiny about the actual requirements of his body and make such reductions in his daily ration as to suit his organism which is decaying with age. It is well said that "a man after 40 is either a doctor or a fool." He

should bear in mind that his various organs, bones and muscles will not admit of further growth, and his only concern should be how to put off the decay and prolong the prime of life. Commonsense will dictate to him that with decaying digestive organs he should make necessary adjustments in his diet to suit the changing organs. If he fails to do so, there will be accumulation of toxins in the system, causing such common diseases as Gout, Diabetes Mellitus, Gastric Ulcers, Pyorrhea, Dyspepsia, and many other kindred ailments, particularly relating to stomach, intestines, liver and kidney. It is firmly believed by Physiologists that men who exercise moderation in the matter of diet beginning from the middle age, generally live longer with the activity fully maintained up to the end than those who overeat themselves. Besides cutting his daily ration quantitatively, a man during middle age should depend more and more upon foods of protective nature, discarding rich dishes and reducing the intake, particularly of such protein foods as pulses, beans, meat and fatty fish. Proper precaution about diet during this period of life is the main bulwark against the senility of old age.

Diet According to Occupation

It has been already noticed that carbohydrates and fats are the means of supplying energy for work, and that work is done primarily at the expense of fat, starch and sugar. So when there is need for more physical work or exercise, the diet should contain comparatively more fats and carbohydrates. A slight addition of protein is also necessary, not because of any increased waste of tissues, but because of the fact that an increase in the amount of nitrogenous substance facilitates the manufacture of digestive juices in larger quantities, and thus aids the digestion of the extra supply of the energy-yielding foods. Moreover, the nitrogenous food, specially of animal kind, stimulates the combustion of fats and

starches in the body, and thus the energy for doing hard work is more easily liberated. The nature of the diet should also vary to some extent between a person who works with brain and a person who works with muscle. The reason is that the brain worker expends much more of the nervous energy which can be replaced by foods rich in protein, than the manual labourer who specially needs foods rich in carbohydrates and fats for his muscular energy.

Diet According to Sex

Women naturally require less amount of food than men owing to their delicate organism, their smaller bulk and weight with decreased basal metabolism, and also owing to the nature of their duties at home, which do not involve much muscular labour. When women are, however, engaged in outdoor work, they naturally require an increased amount of food, the nature of which approaching more nearly to that required by active men. Although quantitatively women require less amount of food than men, qualitatively they must have a more liberal share of foods of "protective" nature than men, to meet their special biological needs in connection with motherhood, the detailed consideration of which will come up in due course.

Diet According to Climate or Season

Both the quantity and nature of diets demand modifications to suit climatic or seasonable changes. It would be well to remember here that the maintenance of the normal body heat, say at 98°F, is essential to our health and vigour. The external temperature naturally influences our body heat, and the colder the climate is, the more rapidly does the body lose its heat. We know it is mainly the combustion of carbon that provides heat and energy to the body, and hence the intake of highly carbonised foods in cold weather becomes imperative. The fats and carbohydrates, parti-

cularly the fats, which contain more carbon than any other substance, should be taken in larger amounts in a cold climate. We have already noted elsewhere that for increased combustion we not only require more carbon, but also more oxygen. The air being dense in a cold climate, a certain volume of air will contain a larger quantity of oxygen than the same volume in a warm climate. Hence a person will imbibe at each inspiration a greater amount of oxygen. Thus nature herself supplies us with the additional oxygen necessary to the proper combustion of the increased intake of carbon in a cold region. In a warm climate, there is less loss of heat, and, therefore, less need for its liberation in the body. This necessitates a reduction in the quantity of food, specially of the kind which is highly carbonised. It should also be remembered that the air in a warm climate is rarefied, *i.e.* a certain volume will contain much less oxygen than the same volume in cold climate. This also suggests the necessity of taking a smaller quantity of fatty substance in a warm region. In short, the food in a warm climate should be light and simple, with a very minimum quantity of fats.

Diet for Expectant and Nursing Mother

The question of diet for the expectant and nursing mother deserves special treatment. They are the custodians of the health and vigour of the future citizens of the world. A healthy mother usually assures a healthy child. It is from the blood of the mother that the fœtus and also the new-born babe continue to receive proper nourishment till it is weaned. This necessarily calls for the extra nutritional needs of the mother not only for the nourishment of her own body but also for the development of the embryo or the suckling child. All the elements of food have to be increased to a certain extent in her dietary to enable her to perform this double function. Foods also must be of such character as to give her the

most efficient form of nutrition, and this necessitates a liberal addition of what is called "protective foods" in her diet. "Protective foods" are those which, as may be remembered, are particularly rich in mineral salts, vitamins, and also what is called "good" protein. The best protective foods are milk and its products, eggs, leafy vegetables, fruits, glandular tissues, such as liver and kidneys of animals.

We have found how mineral salts and vitamins are essential to growth, and how their deficiencies are responsible for some fatal diseases like Rickets, Beri-Beri, Pellagra, etc. We are also aware of the all-important function of protein in the process of body-building. If these protective elements of food are necessary to the nutrition of a person doing ordinary duties of life, how much more are they so in the case of a pregnant woman and a lactating mother? "Good" protein which admits of ready assimilation, provides the mother and her fondling with the means of getting an easy access to the material for building and repairing the tissues. Mineral salts, particularly those of Calcium, Phosphorus, Iron, and Iodine are of special values to the mother and the child. Calcium salts and phosphates form the very substance of the bones, and if the diet of the mother is deficient in these salts, she has to sacrifice the substance of her own bones for the formation of the bones of the child, with the result that she is often attacked with a fatal disease known as Osteomalacia which is common among the child-bearing women. The tissues and the organs of the child are also badly constructed owing to defective calcium metabolism. Iron salts are particularly necessary for the prevention of Anæmia which often proves dangerous to the mother as well as the child. The adequate supply of iron salts presents a very difficult problem. While milk is rich in Calcium and phosphorus, it lacks iron, and this rules out the possibility of the child to obtain any iron salt from the mother's milk. Fortunately, however, the child is born with

a reserve of iron which lasts for about six months. The above facts make it imperative for the expectant mother and also a child past six months, to have a fair supply of iron salts in their diets. Iodine also plays an important part in the development of the child. Its deficiency causes goitre, a disease of the thyroid gland so common among the children. In order to guard against this danger, provision should be made to assure a small quantity of this mineral in the mother's diet.

Besides these salts, the diet of the mother should be rich in important vitamins. The two vitamins which are of special significance to the mother and the child are vitamins B and D. The absence of vitamin B_1 in the highly polished cereals causes the incidence of Beri-Beri and Œdema, which are very common among the mothers. It is, therefore, necessary that the mother's diet should consist of lightly-milled cereals, preferably hand-pounded rice and wheat, and this will assure the adequate intake of this vitamin. The incidence of rickets so common among the children, indicates the deficiency of vitamin D in the foods of the mother as well as the child. The sunshine being a natural activating agent of this vitamin, it is not difficult to obtain this vitamin in sunny tropical countries. But in countries with poor sunlight, particular care should be taken to provide for this vitamin in the diets of both the mother and the child. A daily ration of cod-liver oil in small doses will correct the deficiency. Regarding the two other important vitamins A and C, they can be had easily from milk, fresh green vegetables, fruits etc.

The following figures indicating the protein and calorie requirements of the mother will prove a valuable guide in constructing her diet. These figures furnished, as they are, by a Committee of the League of Nations, admit of a very wide application. Naturally, therefore, the figures demand modifications to suit conditions in different countries:

Calorie Requirements:

Pregnant Women	2,400 Calories.
Nursing Mothers	3,000 ,,

PROTEIN REQUIREMENT

Pregnant women ...	3 months ...	One gramme per kilogramme of body weight.
Do. ...	4 to 9 months ...	1·5 gramme per kilogramme of body weight.
Nursing mothers ...		2 grammes per kilogramme of body weight.

The following table furnished by the Nutrition Research Laboratories at Conoor, will indicate the extra requirements of the important elements of food in percentages in the mother's diet.

	Percentage increase in requirements.
Calories	25
Protein	50
Fat	10
Calcium	100
Phosphorus	50
Iron	50

How to Simplify the Problem of Diet

It cannot be denied that the problem of diet is a fairly complex one, and it is difficult for an average man to construct a model

dietary, inspite of the fact that he is now in possession of all the relevant data. The knowledge we have so far acquired is undoubtedly of immense value to us, but the average people have not the time nor the patience to take proper stock of the values of different food-stuffs and prepare the bills of fare in such a way as to meet their maximum nutritional needs. What they require is a ready-made table or a series of tables indicating in precise terms the amounts and kinds of food-stuffs which should constitute their dietaries. This is all the more necessary for the benefit of general masses, and our study of the problem of diet will remain incomplete so long we cannot reduce it to a form which would prove simple and intelligible to one and all. Up to this time, we are familiar with the various tables formulated by nutrition experts from time to time, covering only the different constituents of food required for a balanced diet, but all these tables, however valuable they may be, do not throw any light on the amounts and kinds of food-stuffs from which we can obtain the necessary constituents in right proportions. In recent times, however, all the civilised countries have focussed their attention upon determining the dietetic needs of their respective peoples; and as the result of intensive researches, we are now in possession of many new facts and figures which have simplified the problem of diet to a considerable extent. Let us now try to understand some of the broad facts considered by the nutrition workers in constructing an optimum diet. Many of them have taken protein as the starting point of their enquiries. It has been found by a series of experiments that the protein requirement of an average adult varies from 80 to 100 grams per day, and this quantity can be obtained from a properly mixed diet weighing from 2½ to 3½ lbs. It has also been found by proper calculation that the caloric value of such a diet amounts to about 3,000—a fact suggesting that the diet contains the energy-yielding material in requisite quantity. It follows then that if we take care of the protein, the other two major

constituents of food, *i.e.*, carbohydrates and fats, will take care of themselves.

Now as to the mineral salts, our first object is to obtain the necessary amounts of calcium and iron. They are the two key-salts, and if they are available in proper quantities from our daily food-stuffs, other essential salts will follow as a matter of course. It is found that copper, manganese, cobalt and a few other elements accompany iron in food-stuffs while phosphorus and magnesium closely follow calcium. Now iron is generally available in cereals, specially whole wheat, legumes, egg-yolk, some nuts and some leafy vegetables like cabbage, lettuce, spinach, etc., while calcium is chiefly found in milk and dairy products, egg-yolk, the pulses, wholemeal flour, fruits and some vegetables.

Next comes the question of vitamins in an optimum diet. It has been already seen that the wholemeal flour, green vegetables, fruits and dairy products are the best sources of some essential minerals and also of vitamins A, B complex, C and E, and so their consumption ensures the supply of the most essential vitamins except vitamin D which, however, the skin of man can synthesise under the influence of bright sunlight.

All the above discussions suggest that an optimum diet should consist largely of cereals, particularly whole wheat, milk and other dairy products, meat, fish, eggs, pulses, green vegetables and fruits, and the total amount will vary from 2½ to 3½ lbs. in the case of an average adult. These food-stuffs are so common and well-known to us that it is easy for a man with ordinary intelligence to prepare his courses of food in such a way as to give him adequate nourishment. In fact, these food-stuffs properly distributed in a diet will almost automatically secure the supply of all the essential constituents of food in right proportions.

In this connection, the suggestion made by an American food

expert Miss Gillet is worth studying. She recommends to divide one's food money into fifths :—

One fifth, more or less, for vegetables and fruits.
One fifth, or more for milk and cheese.
One fifth or less for meats, fish and eggs.
One fifth or more for bread and cereals.
One fifth or less for fats, sugar, and other food adjuncts.

In the light of the present discussion, it will now be admitted that the problem of diet is made much easier for us, and in order to have a more precise knowledge about the requirements of a balanced diet, let us study the following table embodying the recommendations of the United Nations' Conference on Food and Agriculture :

Cereals with a fair proportion of wholemeal flour	10 ozs.
Vegetables (roots and tubers)	8 ,,
,, (others, including green) ...	8·4 ,,
Fruits	5 ,,
Fats and oils	2·6 ,,
Milk	21 ,,
Sugar	1·5 ,,
Meat, fish and eggs	5 ,,
	61·5 ,,

Let us now see what the Nutrition Advisory Committee to the Government of India says regarding the composition of a balanced diet for an adult Indian :

Cereals	14 ozs.
Pulses	3 ,,
Vegetable oil or ghee	2 ,,
Vegetables	10 ,,

Fruits	3 ,,
Milk	10 ,,
Sugar and Gur	2 ,,
Fish and Meat	3 ,,
Egg (one)	1 ,,
Total ...	48 ozs.

N.B.—For the vegeterians who do not take fish, meat or eggs, a corresponding increase in the milk intake is recommended.

In comparing these two tables, we are at first struck with the wide range of difference between the two diets. The diet recommended by the United Nations' Conference is much richer, and more varied than the Indian diet. The former being international in character is meant to cover the requirements of peoples of all climes, and, therefore, the scale is much higher, while the latter covers only the requirements of Indians who, living as they are in a warm climate, require less food than those living in colder regions. Besides, the Indians are generally of lighter make with smaller body surface than the Westerners, and this also accounts to some extent for the difference.

CHAPTER XVII

THE PROBLEMS OF DIET IN INDIA

Diets of the Indian Masses

In the last chapter, we have noted what should be a balanced diet in the case of an average Indian adult, as formulated by the Nutrition Advisory Committee to the Government of India. It now remains for us to take a note of the average diets prevalent among the common people in different parts of India and see how far they fulfil the requirements of a balanced diet. It should be remembered that the figures given overleaf are necessarily approximations covering, as they do, a wide range of people living in different parts of India, and should be read with some reservation. All the figures are taken from the "Health Bulletin" issued by the Nutrition Research Laboratories, Conoor.

All these typical diets show how they fall far short of an optimal diet. They are practically devoid of protective elements of food, and even quantitatively they are much below the standard. In short, they exhibit deficiencies from all points of view, so much so that they can be well called "starvation" diets.

Even the diets of the well-to-do people of India generally lack the requirements of a well-balanced diet, partly due to their ignorance of the dietetic principles and partly due to their leanings towards rich and delicious dishes. They often overeat themselves, particularly in regard to foods rich in proteins and fats, with the protective elements of food ill-distributed. Moreover, they are prone to indulge too much in delicacies like sweets, condiments, fried and preserved foods etc. All these often lead to ill-balanced diets causing such common ailments as Diabetes Mellitus, Gout, Rheumatism, Dyspepsia, Obesity etc.

Mean daily intake of various foodstuffs in groups of families surveyed in various parts of India (Ozs. per adult man daily).

	Madras (Rural area)	Madras (Urban area)	Madras Tea plantation labourers.	Bengal (Rural area)	Assam (Rural area)	Orissa (Rural area)	Central Provinces (Rural area)	Northern India (Rural area)
Rice	15·0 (millets 2·0)	14·2	18·9	25·0	19·4	19·0	26·0	2·5 (Wheat 14·9)
Pulses	0·5	0·9	1·0	0·4	0·9	1·1	1·1	1·4
Leafy vegetables ...	0·3	0·6	none	0·2	0·8	1·4	1·5	6·7 (Leafy & Non-leafy)
Non-leafy vegetables ...	0·9	2·8	3·0	7·0	4·0	6·0	3·0	
Vegetable fats and oils	0·1	0·5	0·5	0·3	0·3	0·3	0·2	3·4 (including ghee, milk & products)
Fish, meat and eggs ...	0·8	1·5	1·5	0·7	0·7	0·6	negligible	0·5
	19·6	20 3	24·9	33·2	26·1	28·3	31·8	29·4

N.B.—Condiments and spices in small quantities are included in the diets. Gur or sugar is also consumed in small quantities.

Malnutrition in India—Its Consequences

It has been seen how miserably the diets of the Indian masses fall short of the balanced diet, and how such deficiencies are undermining their vitality slowly but surely. The problem of diet has now become a national issue everywhere in the world, and more so as a result of the recent devastating war. The knowledge about the science of nutrition has undoubtedly advanced by leaps and bounds during recent years, but the practical application of the advanced knowledge on a mass scale is yet far from realisation. Dissemination of the newer knowledge of nutrition by various means of propaganda will certainly do a lot of good, but this alone can hardly touch even the fringe ot this most difficult problem. The whole problem centres round the question of Rupee, Anna and Pie, and unless steps are taken to improve the financial condition of the masses, no lessons in the matter of a balanced diet by means of propaganda, however extensive and varied it might be, can help in improving the dietaries of the masses. There is certainly a close relationship between food and income. When the income increases, there is generally an automatic increased investment in food-stuffs, and curiously enough, in those which have protective values. However, a healthy propaganda has a value of its own, but propaganda without improving the financial condition of the masses is like putting the cart before the horse. The burning question in India to day is economic and social, and from a long view no amount of subsidy, however liberal it may be, can meet the nutritional needs of the masses. It is no longer a secret that India is not self-sufficient in the matter of her food production, and even if means are found to inerease the income of the masses, there will not be enough food available for every mouth from the point of optimum. In these days when there is a cry of hunger practically all over the world, the imports of food-stuffs in bulk from foreign countries are out of question. The only

course left open to us is to increase production both by intensive and extensive cultivation. We are far behind other advanced countries in the matter of production. One or two instances will bear testimony to this fact. On an average, India produces about 800 lbs. of wheat or rice per acre, while Italy used to produce as much as 3,000 lbs. of rice, and Germany 2,200 lbs. of wheat per acre just before the World War II. The wide margin of difference indicates the immense possibility of increasing the yield from our lands by up-to-date methods of cultivation. There is also a large possibility of increasing the out-turn of "protective foods" like dairy products, poultry, eggs, meat and fish, if properly explored. Milk, as we know, is the best of all "protective foods," and it seems incredible that India possessing, as she does, about one-third of the world's total cattle, produces only a little more than 10% of the world output. We have about as many as 200 million cattle, but the average yield per cow is so low that the total quantity is not enough even to meet the needs of half the population in the light of optimum. The average yield of an Indian cow is less than 2 lbs. as against 20 lbs. in Holland, 17 lbs. in Switzerland, 15 lbs. in England and 14 lbs. in New-zealand. These figures show what we can possibly do in the way of increasing the yield of milk by allowing proper fodder to the cows and also by meaus of improved breeding. Fish is a good "protective food," and with the facilities offered by an extensive network of our water system including high seas, innumerable rivers, khals, bhils, tanks etc., there is no reason why there should not be enough fish if our fisheries are developed on scientific lines, as in Europe, America and Japan. In the same way, the number of poultry, sheep, goats etc., may be multiplied to a considerable extent. It should be borne in mind that the population of India is increasing at the rate of about 5 millions per year, and this, undoubetedly, makes the problem of nutrition more complex.

The extent of the shortage of food-stuffs, particularly those of protective nature, can be well gauged from the study of the following figures published by the Imperial Council of Agricultural Research, indicating the percentage increase in the production of various food-stuffs required to provide the balanced diet on a minimum basis, for 400 million people of India :—

Cereals to be increased by ...		...	10	per cent
Pulses	...	...	... 20	,,
Fats and Oils	...	...	... 250	,,
Fruits	...	...	... 50	,,
Vegetables	...	...	... 100	,,
Milk	...	...	... 300	,,
Fish and Eggs ...		...	... 300	,,

It would appear that the above figures err on the side of moderation, when studied in the light of the present economic disequilibrium caused by the havoc and destruction of the World War II. However, these figures coming, as they are, from an authoritative quarter, provide useful data for assessing the extent of malnutrition prevailing in India. On a modest estimate, more than 30 per cent of the population has not enough to eat even in normal times, and when, on top of this, famine recurs periodically due to play of elements, there is no limit to the number of starvation and semi-starvation cases. Thus undernutrition or strictly speaking, malnutrition has come to be a permanent feature in our social economy. The most harmful effects of such malnutrition are manifested in the high death-rates and the general deterioration of health, particularly among infants and mothers. The infants are the future citizens of India, and as their health and vigour are inextricably bound up with the proper nutrition of the mothers, particularly at the initial stage of development, we can realise how chronic malnutrition is retarding the healthy development of India as a nation.

A comparative study of the mortality figures in India and in other civilized countries is an object-lesson to us. The general mortality rate in India is about 24 per thousand annually as against 12 in England and 11 in U. S. A. The infant mortality presents a more lurid picture. Taking both the urban and rural areas together, the infant deaths on an average are in the neighbourhood of 200 per thousand annually, compared with about 60 in Great Britain and U. S. A. No fewer than a million and a half infants die annually in India before attaining the age of one year, and they constitute about 25 per cent of all deaths as against 7 percent in England. On a rough estimate, about 50 per cent of the total annual deaths in India occur among children under 10 years, as compared with only 10 per cent in England. Now let us look at the figures of maternal mortality during child-birth. It is estimated that about 25 mothers die in India for every thousand maternity cases as against figures varying from 2 to 8 in different European countries. The figures obtained from various tea gardens in Assam are simply appalling—the maternal mortality rate even mounting to as high as 200 per thousand cases in some districts. In this connection, the innumerable cases of pre-natal deaths and still-births naturally come up for consideration, inasmuch as most of these unfortunate cases are directly the result of malnutrition of mothers.

These all-round high death-rates in India are naturally reflected upon the longevity of the people in general. The average expectation of life in India is as low as 30, while in England and U.S.A. it is about 60. A sad contrast indeed!

The facts and figures indicated above, read like a fantastic story, and indeed furnish a pathetic example of the extent of inertia into which a people and a government calling themselves civilized, can sink. The situation has gone beyond the stage of any academic discussion, and what is immediately required, is a sustained drive

under a planned economy, increasing not only the all-round production of food-stuffs, but also the purchasing power of the masses. Proper education and propaganda in various forms should, undoubtedly, form an important part of the programme. Extensive social welfare works like the establishment of maternity homes, nurseries, creches, provisions for school and factory feeding, proper housing, sanitation etc., will naturally come into the picture to carry the programme to its logical conclusion. Only elaborate and vigorous activities on these lines can save India from all the horrors of malnutrition, and ultimately give her people that joy of abundant health, vigour and stamina which they need so much for the re-orientation of India's economic, social and political life, and securing for her an honourable place in the comity of nations.

CHAPTER XVIII

DISEASE AND DIET

We have already noted how diets should vary to suit different conditions under which men live. Age, sex, nature of work, climate and other environments are the various factors which determine our diets to a great extent. It is now for us to examine how diets should vary according to diseases. An exhaustive treatment of the subject would cover a whole book, and in our present study, it is enough for us to understand the general principles which would prove a proper guide in selecting our diets in illness. When we are ill, our various organs show signs of weakness, their activities become less vigorous, and their resisting power becomes diminished. It follows then that our diets in illness should be of such nature as can

be easily digested without placing much strain on our system. But it should be remembered that a diet which is proper for one person may not be proper for another even in health, and more so in cases of persons suffering from illness. A diet suitable to a patient afflicted with one disease, may prove harmful and even dangerous to another suffering from a different disease. Prudence should, therefore, play an important part in selecting the diet of a patient. Nature of the disease, individual temperament and taste, duration of illness, and other factors demand careful consideration. Medicines have certainly their values in the treatment of diseases, but generally prove ineffective, if not implemented by proper diets. In many cases, the regulation of diet is more important than medicines in effecting recovery, and in fact, it is the proper diet that ultimately brings about radical cure.

The amount and character of the diet in illness should be adapted, not so much to the hunger of the patient as to the power of his digestive organs. It is not wise to give too much food to the patient at a time. He should eat rather oftener but little at each time. The most important thing to remember is that the food given does not tax the digestion of the patient. Subject to this consideration, the food should generally contain a fair amount of nutrients, and also it should be pleasing to the palate.

It is often the over-nourishment of the patient that does the most mischief. The watchword "hasten the recovery slowly" would usually keep him on the safe side. A man can live even without food for a pretty long time, and there is no reason why a patient should have an oversupply of food causing unnecessary strain on the system which is already weakened by the disease. Rather it is often better to starve than overload the system. This brings us to the consideration of the benefits of fasting, and its close association with diet during illness. Fasting even for a day, particularly at the initial

stage of a disease, usually does a lot of good. The toxic condition of the blood is generally an accompaniment of most of our ailments, and an attempt must be made, at the first instance, to wash out the poisons from the body and prevent their further accumulation. This can be done only if we begin our treatment by taking recourse to fast and drinking plenty of water. There are records of cases in which the patients have recovered marvellously, only by taking to fast. Animals which instinctively refuse food in illness, provide us with a lesson from Nature.

Duration of fasting will, of course, depend more or less upon the nature of illness, and particularly upon the constitution of the patient. After breaking the fast, particular care should be taken about the diet, because the digestive organs during the period of fasting become more or less inert, and a sudden return to normal diet is apt to bring indigestion and many other painful complaints. Foods should, therefore, be slowly and steadily increased in order to give the digestive organs time to recuperate. A start should be made with fruit juices, gradually adding milk and vegetable juices. This liquid diet should be continued for some time until the patient is fit enough to take semi-solid diet, which will at last lead him to a return to the normal diet. The period of taking liquid and semi-solid diets will generally depend upon the duration of fasting and also the nature of illness.

We have so far tried to understand how correct feeding exercises a curative influence on diseases; and in order to obtain a complete picture of correlation of disease and diet, we should bear in mind that, after all, wrong feeding is at the root of most of the human diseases. It is believed that about 75 per cent of human diseases can be more or less attributed to errors in diet. Indiscreet eating ultimately leads to malnutrition with the inevitable consequence of impaired vitality and reduced power of resistance to diseases. It is

obvious then that with proper diets and nutritional efficiency, most of the diseases are preventable, and prevention is certainly better than cure.

As has been already pointed out in our previous study, denaturalised foods are a curse of the modern civilisation, causing a number of "deficiency" diseases, and general deterioration of health. We may go a little further and say, though by way of a little digression, that besides natural foods, natural ways of living have also an important bearing upon the enjoyment of positive health and longer life. Evidences are not lacking on this point, and one just coming from an authoritative quarter in Russia is interesting and worth reproduction. Professor Ilyin, Russian authority on human ages, says" Nowhere else in the world do people consistently live to a greater age than in the Caucasus. Four years ago there were 25 people between 126 and 136 years old in Russia, and the last Russian Census showed that there were no fewer than 30,000 Russian aged 100 years or more—most of these people living in the Caucasus." Although Professor Ilyin is silent about the cause of this mysterious phenomenon in the Caucasus, it may be said with some confidence that behind the secret lies the simple truth that people thrive best when they live in close contact with Nature.

Now to return to the main topic of our discussion, *i.e.*, the regulation of diets in diseases. Our limitation in this book does not allow us to tabulate a detailed list of diets for various diseases, but a brief survey of the general rules of dieting in relation to some common diseases will provide useful data for exploring a much wider field.

Diarrhoea

In common diseases of digestive organs, diet is often more important than medicines. In the acute stage, total abstinence from food for a few hours is beneficial. Food must be restricted to

liquids. Green cocoanut-water and whey can sustain a patient for some time, particularly owing to their containing good amounts of vitamins and mineral salts; juices of fruits like oranges, lemons, pineapples, pomegranates, are also helpful. Barley water, butter-milk and curd may be given preparatory to returning to normal diet. Curd should be restricted if the liver is bad, as all foods must be fat-free as far as possibe. Foods causing fermentation or leaving residues, should be avoided. Irritating foods are tabooed. Foods should be taken in small quantities at short intervals.

Dyspepsia

Foods should be chewed thoroughly. Leguminous foods like pulses, beans, must be discarded, so also highly stimulating condiments, fried articles, very hot or cold drinks, sweets and acids. Foods should be restricted to well-boiled cereals and vegetables, milk and fruit juice. Animal foods like eggs, fish, meat, may be taken but not too freely. Individual taste and tolerance have to be attended to.

Gastric and Duodenal Ulcers

When the mucous membrane is corroded by the action of the acid of the gastric juice, the ulcers are naturally exposed to the action of the acid causing pain and also retarding the healing process. It is, therefore, very important at first to protect the mucous membrane from the corrosive action of the acid. Feeding at very short intervals, say every two hours, serves the purpose of protecting both the mucous membrane and the ulcer. When there is a constant supply of food the acid acts on the food, and thus the ulcer being left undisturbed gets a chance of healing. The food must be of liquid nature and nutritious. Milk is, therefore, the best type of diet in the treatment of ulcers. Too much addition of sugar causes fermentation, and is harmful. It is only by proper attention

to feeding that ulcers can generally be cured, and medicines are only subsidiary. Acid fruits should be avoided.

Jaundice

Bile secretion being disturbed, fatty foods must be restricted to minimum, if not wholly avoided. Plenty of glucose, butter-milk, juices of fruits like pineapples, oranges, lemons, grape-fruits, pomeloes, should be taken freely at the initial stage of the disease. Curd, starchy foods, green vegetables, and milk will follow later on. Abstinence from fats, spices, and other rich condiments must be continued for some time. Drinking plenty of water and washing the system form a very important part of the treatment.

Constipation

In absence of any complaint in the digestive tract, foods that leave large residues should be taken freely. By causing a healthy irritation in the bowels, roughage facilitates the expulsion of fæces. Whole wheat, oats, plenty of leafy vegetables, fresh fruits, and dried figs, prunes, dates etc., are all helpful.

Typhoid

In this disease, ulceration is formed in the small intestine followed by a disorder of the stomach and generally looseness. Diet should, therefore, be only of liquid kind during the course of the disease. But as the disease is very exhausting and toxic in nature, the food must contain enough nutrients and calories in order to keep up the general strength of the patient. Bland liquids like whey, green cocoanut-water, orange juice, glucose water are most recommended. Barley water properly diluted also proves beneficial. Peptonised milk and milk diluted with barley or lime water may be given according to the condition of the patient. Pure milk, however diluted it may be, is not generally tolerated. In any case, the milk must be properly sterilised. Food must be given in small quantity

at a time, but at frequent intervals. Drinking plenty of water from the very beginning has often a curative effect. This precaution at least prevents the disease from taking a dangerous turn. "Water in and water out" should be the motto of a typhoid patient. During convalesence the patient demands most nourishing foods consistent with his power of endurance, and beginning should be made with milk, vegetable and chicken soups. Then the diet should be gradually supplemented with the white of eggs, bread, biscuits and semi-solid rice. Proper care should be taken that nothing hard is put into the patient's stomach. Any indiscretion in the matter of diet may cause a relapse which often proves fatal.

Kidney Diseases

In connection with the diseases of the Kidney, it should be borne in mind that the end product of the protein metabolism, called Urea, is mainly expelled from the body through the kidney along with the urine. This suggests the elimination of protein foods as far as possible from the dietary, in order to relieve this organ of any unecessary strain. Rich protein foods like meat, fish, the white of eggs, cheese, pulses, nuts, etc. are tabooed for some time. Cereals like rice, whole wheat, herbage, etc., containing a moderate quantity of protein, will be enough for the patient to carry on. In addition to these, green vegetables and fruits rich in mineral salts and vitamins should be taken freely. The mineral salts and vitamins are really beneficial to the patient and assures his early recovery. Common salt must be restricted to its minimum, specially when there are signs of Œdema. Milk though the most easily digested of protein foods, should also be restricted. But when the patient is on way to recovery, the quantity of milk may be gradually increased.

Diabetes Mellitus

In this disease, the metabolism of carbohydrates and fats is out of tune. Therefore, the foods which are very rich in starches,

sugars, and fats should be greatly restricted, if not altogether prohibited for some time. The root vegetables like potatoes, beets, turnips etc. must be avoided, but leafy vegetables should be taken freely. Meat and fish rich in fat should also be avoided. It has been found that the incidence of Diabetes is much higher in countries like U.S.A., Holland and England where fats are taken too freely. In fact, the incidence rises exactly in proportion to the fats taken. Easily digested protein foods like milk, eggs, fish, meat and green vegetables should generally form the bulk of the menus. Diabetes is a very wasting disease, and proper precaution about diet should be taken from the very beginning. In fact, it makes a lasting response only to dietetic treatment, while the injection of insulin gives more or less temporary relief.

Gout

In this disease, there is an accumulation of uric acid in the system, resulting from excessive intake of certain types of protein foods, particularly meat and pulses. The restriction of foods rich in protein is, therefore, suggested as a corrective measure. The intake of meat, fish, pulses, eggs, should be reduced to minimum. Milk and its preparations being the sources of the best type of protein, may be taken without much restriction. Green vegetables and sweet fruits must be taken very liberally, as they are considered to be the best solvents of urates. The dieting should be accompanied with moderate exercise, as sedentary habits retard the process of metabolism.

Rheumatism

Our normal blood is slightly alkaline in character, but in rheumatism it has a tendency to be acid. Protein foods, particularly meat and pulses, must be restricted to minimum. But milk and its products can be taken more or less freely. Vegetables and fruits

should be taken in abundance, as they are the best foods to diminish the acidity of blood. Drinking plenty of water is very beneficial to the system.

Obesity

Obesity or abnormal fatness is naturally linked up with body weight, and we need hardly mention that body weight is a great factor in ascertaining the health of a person. A healthy person at a certain age must have a certain body weight in proportion to his height, and any deviation from the standard with the resultant overweight or underweight, is a positive sign of decaying health. It has been determined with some degree of accuracy what should be the normal weights at different ages in relation to heights. It should be, however, remembered that the normal weights and heights necessarily vary in different countries, particularly under the influence of climatic conditions, the dietary habits and also the socio-economic environments of the inhabitants. Therefore, no single table covering the weights and heights of the people of a particular country, should be taken as universally true. In this connection, it should be noted that in the case of a man in the prime of life, a little higher weight than the average is generally a sign of vigour and health, while in the case of the middle-aged and elderly people the reverse is true.

Body weight is not only influenced by the amount of fat deposited in it, but also by its water content. In the majority of cases, however, it is the accumulation of fat that increases the weight.

Although there are some persons who have a natural tendency to put on fat in the body, it is found that overweight is generally due to indiscreet eating. It is usually caused by excessive consumption of fats and carbohydrates, the surplus portions of which are deposited in the system as fats and glycogen. Fat is said to be manufactured even out of protein. It follows then that for the

control of weight an all-round cut of the food allowance is necessary, and also there should be an increase in the intake of those foods which help to stimulate the process of metabolism. But the cut should not be a drastic one in order to obtain anything like a spectacular result. What is required is an intelligent selection of foods and steady reduction, particularly of fats and carbohydrates in the diet. Minerals and vitamins facilitate the process of metabolism, and necessarily the foods which are rich in these elements, automatically secure the reduction of weight. Leafy vegetables like spinach, lettuce, cabbages, Ipomea, Amarnath, Fenugreek etc., containing plenty of minerals and vitamins are, therefore, very valuable supplementary foods. The above facts suggest that in controlling weight a start should be made with a steady reduction in the intake of carbohydrate and fatty foods, specially those which are poor in minerals and vitamins, adding more and more leafy vegetables in the diet. By the reduction of fats and carbohydrates the weight is controlled in two ways. First, there cannot be any surplus of these elements to be deposited as fat, and secondly, when there is not enough of these elements for the liberation of necessary heat and energy, the accumulated fat in the body is naturally drawn upon to implement the heat and energy required by the body, with a consequent reduction in weight.

Besides limiting the highly carbonised foods in the dietary, there are other methods, more or less artificial, often adopted in reducing weight. The administration of drugs like Thyroid containing, as it does, Iodine, is often resorted to for accelerating the oxidation process in the body, but such a course is said to be attended with immense risk. The regular consumption of Vinegar is another device which on its very face is dangerous. The whole idea of interfering with digestion by setting up catarrah in the digestive canal and causing injury to the whole system, is against all common

sense. Muscular exercise often proves beneficial in the matter of weight reduction, but the process is rather slow owing to increase of appetite and consequent intake of more food. Excessive exercise, however, should be guarded against, specially in cases of elderly people, and as Sherman says "the only form of exercise essential to the control of body weight, is the exercise of intelligence."

TABLES OF HEIGHTS AND WEIGHTS

Bengal *

Height	5′	5′-2″	5′-4″	5′-6″	5′-8″	5′-10	6′
Age	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
25	104	114	117	125	132	141	150
30	108	114	120	128	136	145	154
35	112	118	124	132	140	149	159
40	114	120	127	135	144	155	167
45	116	122	130	138	148	159	171
50	118	124	131	139	149	161	174

Punjab, N. W. F. P. & Sind

Height	5′	5′-2″	5′-4″	5′-6″	5′-8″	5′-10	6′
Age	lbs.	lbs.	lbs.	lbs	lbs.	lbs.	lbs.
25	105	112	119	127	136	145	156
30	109	116	123	132	141	151	162
35	112	119	127	137	146	157	168
40	115	122	131	141	151	162	175
45	118	126	134	144	154	165	177
50	120	128	137	146	156	167	179

*The figures indicated for Bengal are applicable to Bombay, Madras and Central Provinces with slight variations.

The average Height and Weight of people of all Provinces including Parsis

Grouping	Average Height ft. in.	Average Weight Pounds.
Punjab N. W. Fronts Province and Find	5′-5·7″	131-6
Bengal Presidency ...	5′-5·2″	125-7
United and Central Provinces ...	5′-5·2″	125-6
Madras (Including Mysore and Province)	5′-4·9″	123-6
Bombay Presidency ...	5′-4·6″	120-1
Parsis	5′-5·6″	131-0

Great Britain

Height	5′—4″	5′—6″	5′—8″	5′—10″	6′—
Age	St. lbs.	St. lbs.	St. lbs.	St. lbs.	St. lbs.
25	9—3	9—10	10—3	10—11	11—5
30	9—8	10—1	10—8	11—1	11—10
35	9—11	10—4	10—12	11—4	12—0
40	9—13	10—7	11—1	11—9	12—4
45	10—2	10—9	11—3	11—12	12—8
50	10—3	10—11	11—6	12—1	12—11

CHAPTER XIX

COMPOSITION OF FOODSTUFFS

It has been seen how proper knowledge of the composition of foodstuffs is a condition precedent to the construction of dietaries. In this chapter the nutritional values of a few common foodstuffs have been dealt at length, and also simple tables have been annexed in Appendix I covering the composition of a large number of foodstuffs. The tables show the different elements of food in percentages and a little arithmetic will furnish one with the information as to the actual amount of each element contained in a foodstuff of certain weight.

It should be remembered that the figures given in the analysis are only averages based on a number of samples. Necessarily, therefore, in practical application of these figures one should make some judicious allowance to find out the correct values of a particular foodstuff instead of adhering to these figures too rigidly.

Foods fall into two main categories—(1) Animal foods, (2) Vegetable foods. They are again sub-divided into two groups—Nitrogenous and Non-nitrogenous according to their protein contents.

Almost all the animal foods are nitrogenous excepting Butter and Lard, while most of the vegetable foods are non-nitrogenous excepting legumes or pulses. Though the cereals like Wheat, Rice, Maize etc. contain a fair percentage of proteins, they cannot be called Nitrogenous in real sense of the term.

ANIMAL FOODS

Milk

Average percentage composition:

	Water	Protein	Fat	Sugar	Minerals
Human	88·0	1·0	2·9	7·0	0·1

	Water	Protein	Fat	Sugar	Minerals
Cow	87·6	3·3	3·6	4·8	0·7
Buffalo	81·0	4·9	8·8	5·1	0·8
Ass	91·0	1·7	1·0	6·5	0·4
Goat	85·2	3·7	5·6	4·7	0·8

Detailed percentage composition of cow's milk:

Water	Fat	Caseinogen	Lactalbumin & Lactglobin	Lactose	Minerals
87·6	3·6	2·7	0·5	4·8	0·7

Of all the foods, milk is the nearest approach to a complete food, containing all the constituents of food in fairly suitable proportions. No other single food can be a proper substitute for it. It consists of "good" proteins, carbohydrate, fat, mineral salts, and vitamins. Fat exists in the form of butter, carbohydrate in the form of what is called the Sugar of milk or Lactose, proteins mainly in the form of Caseinogen and to a small extent in the form of lactalbumin and lactglobin. The mineral constituents of milk consist mainly of calcium, phosphorus, potassium, sodium and chlorine, with traces of magnesium, sulphur, fluorine etc. It is fairly rich in vitamin A, and is a good source of vitamins B and C, with a trace of vitamin D.

The proteins of milk contain almost all the essential "good" amino-acids which are very easily assimilated into the tissues. The sugar of milk is not liable to easy fermentation as ordinary cane sugar, and is readily absorbed to provide heat and energy most efficiently. The fat of milk is the best of all fats, as it is highly emulsified and very easily digested.

Milk is slightly alkaline in reaction while fresh, but it becomes acid when it is allowed to stand for a long time, exposed to the air. The minute organisms from the air are responsible for the fermentation of the milk-sugar, forming Lactic acid which causes the souring

of milk. Heat destroys organisms, and hence arises the necessity of boiling milk before it is taken. Overboiling should be guarded against, as it causes the loss of some mineral elements and vitamins, especially Calcium and vitamin C. When milk becomes acid it separates into curd and whey. It is the caseinogen of milk and not the lactalbumin or lactglobin that turns into curd. Caseinogen remains dissolved in alkaline solution, and, therefore, as long as the milk is alkaline, it will not curdle. The addition of a little baking soda or lime will prevent curdling. Curdling is the first step in the process of digestion of milk, caused by the action of hydrochloric acid and a curdling ferment called rennin in the stomach.

Milk Diet—Adult vs. Children

Milk is considered to be the best of all "protective" foods, and it should be taken at all ages, particularly because it is rich in calcium and phosphorus which are the essential components of every cell in the body. The pre-eminence of these salts contribute to the most efficient and economic use of such a rare element as vitamin D which in turn is essential to the metabolism of the two salts in question, as already noted. Milk itself containing little or no iron, is believed to help the body to make the most effective use of iron derived from other sources. Its protein also facilitates the efficient utilisation of proteins derived from other foods.

Although milk contains all the ingredients of food, the exclusive diet of milk can by no means give proper nourishment to an adult in all circumstances. As an exclusive diet, an adult would require as much as 12 lbs. of milk to obtain the necessary calories. But this quantity would involve the intake of water and some food constituents, particularly fat and protein, far in excess of what is required for health. It should be remembered that in a standard diet the proportion of nitrogen to carbon is 1 to 16, but in cow's

milk it is 1 to 9, *i.e.* the proportion of nitrogen in relation to carbon is much higher than the basic standard. This means that a mono-diet of milk will give either too much of nitrogen or too little of carbon. Besides, the more liberal secretion of hydrochloric acid in the stomach of an adult than in that of a child causes the formation of large solid masses of curd into which the gastric juice cannot easily penetrate. There is also a considerable waste of materials, particularly mineral salts from the body of an adult on an exclusive milk diet. It has been found that an adult on a milk diet expels from his body from 8 to 10 per cent of milk solids while a child expels only about 6 per cent. The teeth of an adult are also a pointer as to the nature of food he should take. They are obviously meant for mastication of hard foods. Without mastication and some share of starchy foods there cannot be a proper flow of saliva which is so essential to destruction of micro-organisms.

While the exclusive diet of milk is not suitable for an adult, it admirably suits the organism of an infant up to about 8th month. Even after this period a growing child comparatively requires more milk than an adult for body building, because it proportionately contains more "good" proteins than any other complete food. Moreover, as noted before, the acid content of the gastric juice in a child being less than that in an adult, the curd of milk does not form into large flakes in the stomach. Thus it is more readily acted upon by the gastric juice, and admits of easy digestion.

Human Milk vs. Cow's Milk :—As will be seen from the table, human milk contains less nitrogenous and fatty substances than cow's milk, but more water and sugar. Human milk forms smaller flakes of curd than cow's milk. In order to bring cow's milk into line with the composition of human milk, it should be diluted with water. When too much water is added both fat and sugar contents become deficient, and, therefore, an addition of these two ingredients is necessary. Cow's milk requires boiling, because it not only

destroys micro-organisms but also prevents the formation of curd in large masses. Cow's milk becomes more easily acid than human milk, and the addition of a little carbonate of soda or lime water not only preserves its alkalinity, but also neutralises the acid content of the gastric juice to some extent, causing a slow but healthy process of digestion. The reduction of the acid content of the stomach, as already indicated, has the effect of forming smaller masses of curd easily digestible.

It should be noted that cow's milk is rich in fat, and this leads to an intestinal disturbance in the case of an infant unless the milk is properly diluted. The capacity of an individual organism for the digestion of fat, particularly in the case of an infant, is limited. The excess is converted into a soapy substance in the intestine, consisting of a portion of fat and alkalies, and as such it is passed out in the excreta. This excretion of soap brings about a heavy loss of alkaline substances, such as soda, potash, calcium etc., ultimately causing malnutrition.

It is interesting to note here that the fat content in cow's milk varies at different times of the day. The afternoon milk is generally found to be richer in fat than the morning milk. Again the fore-milk, *i.e.*, the first part of the milk is poorer in fat than the latter part. The vitamins A and D contents in cow's milk are also found to vary according to season. During the summer when cows feed on green pastures, these two vitamins show a remarkable increase in milk.

Buffalo's Milk :—It is much richer than cow's milk, inasmuch as it contains more proteins, and more than twice as much fat. Though containing almost the same percentage of sugar as cow's milk, its caloric value is much higher due to its excessive fat content. Its vitamin and saline contents can be compared favourably with cow's milk. The buffalo milk is obviously more suitable for physical

labourers, and ordinarly it should be diluted with water to lessen its fat content.

Goat's Milk :—It contains a little more fat and vitamins A and D than cow's milk, but less sugar. It is also a little richer in mineral salts, and contains iodine which is so rare a mineral. It is sometimes found to possess traces of some insoluble acids, for which reason it is not a very suitable food for all infants. It is cooling, and is believed to possess some therapeutic values.

Ass's Milk :—It contains less protein and fat than any other milk. But it is rich in sugar, almost rivalling human milk. It bears a close resemblance to human milk in its effects and is considered to be the most cooling of all kinds of milk.

Skimmed Milk :—Though the fat is removed, and with it the vitamins A and D, the skimmed milk is very nutritious. It retains intact the protein and the sugar contents of milk, and also the useful mineral salts together with vitamins B and C. Although it contains little or no vitamins A and D, it is a good supplementary food, more so as it can be preserved in dried condition for a considerable length of time. In view of its nutritive property, the skimmed milk should not be wasted, as is often the case in India.

Curd or Sour Milk (*Dahi*) :—Curd is one of the best "protective" foods. It contains all the ingredients of milk including vitamins, with slight variations. The acidity of curd is believed to have a preservative influence on vitamins as well as minerals. Being a concentrated food, its protein and fat contents are a little higher than those of milk, but its sugar content is nil. It is the sugar that is converted into lactic acid by the activities of some harmless micro-organisms in the air, giving curd its sourish taste. These harmless microbes prevent the growth of any other germs of harmful nature, and, therefore, the keeping property of curd is much better than milk. It is more easily digested than milk, particularly when diluted with a little water to break the large solid flakes. It is very soothing

and refreshing, and also laxative to some extent. McCarrison says "wherever sour milk is used freely as a staple article of the diet, the people using it are exceptionally strong and long-lived." It may be pointed out that the lactic acid not only prevents the growth of poisonous germs, but also neutralises the effects of intestinal putrefaction to a great extent.

Butter-Milk :—When cream or curd is churned, the fat is separated, and the residue is butter-milk. It is naturally lacking in vitamins A and D due to the extraction of most of the fat, but it contains all other ingredients of milk. If it is not too much diluted, its nutritive value remains fairly high. It is very cooling and refreshing in warm climate, and more easily digested than curd. It is a beneficial drink in all sorts of digestive troubles.

Whey & Casein (Channa) :—When milk is treated with lemon juice, alum solution, rennet, etc., the caseinogen of milk precipitates as what is called in India "Channa", and the remaining fluid portion is called whey. Whey contains only lactalbumin and lactglobin and little or no fat, and practically none of vitamins A and D. But it maintains in tact the milk sugar and vitamins B and C. It also retains a fair proportion of salts, particularly calcium. If prepared with lemon juice, the whey becomes reinforced with vitamin C. It is a very suitable diet during prolonged illness enabling the patient to keep up the resisting power.

Casein or "Channa" is a highly concentrated food with about 22 per cent protein, 18 per cent fat and 1·75 per cent minerals, but its sugar content is as low as 1 per cent, the bulk of the sugar remaining concentrated in the whey. It contains vitamins A and B, with a trace of vitamin D.

Cheese :—It is made from clotted milk by hardening its curd. It retains almost all the proteins of milk, a very large proportion of calcium and phosphorus, and vitamin A with traces of vitamins

B and D but no vitamin C. It contains very little sugar. There are different kinds of cheese, and its fat content varies according to the method by which it is prepared. It is a very concentrated food consisting of very high precentages of protein and fat, and should, therefore, be taken sparingly as a supplement to other foods. It is said that cheese has the property of breaking the curd of milk into smaller masses in the stomach, thus facilitating the digestion of milk when mixed with it. Grated cheese is more easily digestible than slab cheese, inasmuch as the gastric juice can act upon the former more quickly.

Condensed Milk :—There is no standard composition of condensed milk. The composition varies according to the quality of the milk and the process by which it is concentrated. In some cases cane sugar is added, and this also accounts for the difference in the composition. It naturally contains much lower percentage of water but much higer percentages of proteins, fats and sugars than the ordinary milk. It is generally found that the average strength of the condensed milk varies from 3 to 4 times the ordinary milk. It is, therefore, necessary to add about 4 ozs. of water to every ounce of the condensed milk to restore it to the degree of the strength of the original milk.

Even when such diluted, this milk can not be a complete food, inasmuch as it has already lost some of its vitamins and minerals, particularly calcium and vitamin C in the course of condensation by boiling. The sweetened condensed milk, though advantageous owing to its keeping property, is less nutritious than the unsweetened brand. The presence of a large amount of sugar not only adversely affects all the nutrients, but also tends to cause intestinal disturbances. It is, therefore, a very injurious food for infants.

Evaporated Milk :—When water is evaporated from milk at a sufficiently high temperature, it becomes thick and is called " Khir " in our country. The high temperature at which the milk is boiled,

kills all bacteria without affecting very much its nutrients except vitamin C and its calcium content. Therefore the evaporated milk properly diluted is quite good from the nutritive point of view, provided juices of fruits like oranges, tomatoes etc. are given to children by way of compensation for the loss of vitamin C and calcium.

Milk Powder :—It is manufactured by various industrial processes. The temperature at which the drying process is carried on largely determines the nutritive values of the original milk. In any case, there is not much loss of the major elements of food, *viz.*, proteins, carbohydrates and fats. It is the vitamin content that is most affected, particularly vitamin C, and also, to some extent, its calcium content. When the fluid milk is half or fully skimmed, the powder naturally lacks also vitamin A. Therefore, when children are fed on milk powder they should be given plenty of orange, lemon and tomato juices to make up the deficiencies of vitamin C and calcium, and also a small dose of Cod-liver oil to restore vitamins A and D, when the source of the powder is skimmed or half-skimmed milk. The milk powder can be reconstituted into fluid milk by adding to it 10 times of water.

Butter :—It consists mainly of milk fat obtained from the cream by churning. Butter and cream, being highly emulsified, are the most easily digested of all animal fats. Butter contains about 85% fat with sight traces of protein and sugar, and is very rich in vitamin A. It also contains a little vitamin D but no vitamins B and C. Almost all the important mineral salts are present in it, but in small quantities. The proportion of vitamin content depends upon the food of the animals. It invariably increases in summer when the animals feed on green grasses. Butter is a complex substance containing a mixture of various fats. Bad flavour in some butter is caused by the decomposition of some of its fat contents. The fatty acids formed by the decomposition are soluble

in water, and hence the bad flavour can be removed by washing the butter several times.

Ghee or Clarified Butter :—When butter is boiled, it is turned into ghee. It lasts much longer than butter, and is, therefore, very popular in a hot country like India where butter quickly becomes rancid. It has practically all the properties of butter. When preparing ghee, the butter should be boiled in closed vessels, as exposure to the air is apt to cause a partial loss of vitamin A. It is less digestible than butter, because the evaporation of water separates the particles of fat, which cannot be easily acted upon by digestive juices. It has been found that vitamin A content is much higher in cow ghee than in buffalo ghee.

Eggs

Average percentage composition :—

	Water	·otein	Fat	Minerals
Duck's egg ...	71·0	13·5	13·7	1·0
Hen's egg ...	73·7	13·3	13·3	1·0
Yolk	53·0	14·0	30·0	1·2
White	87·0	11·0	—	1·0

Eggs occupy a very high place in the list of the "protective" foods. The shell is about one-tenth of the total weight of an egg, the yolk three-tenths and the white six-tenths. Eggs contain "good" protein and highly emulsified fat in fair amounts, but hardly any carbohydrate. They are fairly rich in Vitamins A and B, and also contain vitamin D but no vitamin C. They are good sources of important mineral salts like phosphorus, calcium, iron, magnesium, sodium and potassium. The white of an egg practically consists of only a pure protein called albumen with a very slight trace of carbohydrate but with no fat. It contains only vitamin B in the form of Riboflavin with little or no trace of other vitamins. All the important mineral salts are more or less present in it. The

yolk is particularly rich in fat and vitamins A, B and also D. It is also much richer in phosphorus, calcium, and particularly iron, than the white portion. Though it contains a little more protein than the white, its protein is not so pure as that of the latter. The proteins of the egg consist of two groups—Ovalbumen in the white and Ovavitellin in the yolk.

On the whole, the egg contains a fair percentage of the purest and most available form of proteins, and for this reason, more than anything else, it is considered to be a very concentrated food, and should not be taken in large numbers.

Although eggs are fairly rich in both the body-building and energy-bearing substances and also protective elements of food, it is not practicable for a person to live on eggs alone. An average man would require about 18 eggs per day to receive the necessary amount of protein, but this would involve the intake of too much fat, causing intestinal disturbances of a dangerous kind and many other complaints.

Fully boiled eggs are hard to digest, because the heating process clots the chief constituents of eggs, preventing the digestive juices from acting upon them easily. Whipped eggs are readily digested due to the reduction of the constituents into minute particles. Dried eggs which were extensively used during the World War II, are quite good sources of nutrients. A duck's egg contains a little more of nourishing substance than a hen's egg.

As compared with milk, eggs do not contain vitamin C, but contain much more vitamin A, phosphorus and iron, but less calcium than milk.

Preservation of Eggs :—The shell of an egg being porous, permits the entrance of air into it, and we know how the germs in the air cause putrefaction. This may be prevented by rubbing the eggs over with a fatty substance. It is said that eggs can be kept fresh for even a year by covering them with a

solution consisting of one-third wax and two-third olive oil. They may also be preserved in a strong solution of salt or in lime water or by coating of lime.

How to Test Eggs :—(1) When the centre of an egg looks transparent before a light, it is fresh, but when the ends look transparent, it is bad.

(2) Fresh eggs sink and bad eggs float in a solution composed of 1 oz. of common salt and 10 ozs. of water. Even in pure water bad eggs almost float on account of its loss of water and the formation of gas, caused by decomposition.

Meat

Average percentage composition :—

	Water	Protein	Fat	Minerals
Lean Mutton ...	74·0	17·0	3·0	4·0
Fat Mutton ...	56·0	11·0	28·0	3·0
Chicken	74·0	21·0	3·0	1·0

Meat can be called a "protective" food, because it contains a very fair percentage of "good" proteins, and also valuable mineral salts and vitamins, though in moderate amounts. It contains a little of each of the vitamins A, B, & C. Fatty flesh is, however, rich in vitamin A. It is poor in vitamin B, and the little amount of vitamin C (ascorbic acid) which it contains, is largely lost in the process of boiling. In view of the general deficiency of its vitamin contents the excessive meat eaters should have plenty of these vitamins from other sources. It is rich in phosphorus but poor in calcium.

Glandular organs like liver, pancreas, kidneys, brain etc. are more protective than the muscular flesh. Besides "good" proteins, they contain more vitamins, particularly vitamin B (Riboflavin).

They are also believed to be rich in a substance which stimulates the formation of red blood-cells in the marrow of the bones.

Liver is fairly rich in vitamin A, and is a good source of iron and manganese which play a very important part in the formation of blood. Liver extract is, therefore, considered a good remedy for anæmia. Liver is undoubtedly a valuable animal food, inasmuch as it is considerably rich in all the protective elements of food, and also glycogen. It is from the liver of their preys that carnivorous animals obtain the valuable mineral salts and vitamins.

Brain is another good source of iron, and also of two rare mineral elements—copper and zinc. It is particularly rich in vitamin B, and also some valuable fats and phosphorus.

Wild animals are generally less fatty than the domesticated animals because their free movements involve the loss of energy-yielding substances, *viz.*, fats and carbohydrates. Although the flesh of the wild birds and animals is less fatty, it is richer in proteins, more tasty and more easily digested. It is the flavour of the flesh that gives taste, and the flavour depends upon what is called extractives (kreatin). The extractives, though nitrogenous in character, are not really proteins for the body-building purpose. They are so-called because they can be extracted from flesh by means of water. Natural feeding and free life add to the flavour of the flesh of an animal, and it is particularly for this reason that the flesh of the wild birds and animals, and also mountain-fed sheep, is so tasteful. Venison, the flesh of the deer is poor in fat, but rich in extractives, and, therefore, it is tasty and easily digested. The flesh of young animals is poor in extractives, and, therefore, less palatable than that of mature animals, and it is less nutritious and less digestible, though more tender. Again, the flesh of an animal quickly fed and fattened is less nourishing than that of an animal which thrives naturally. The fact is that the muscles of an animal must attain the proper development before they can

supply the full quota of nutrients and extractives. The white-coloured flesh is generally more easily digested than the dark-coloured one. Among the common meats, the flesh of goat and sheep are most popular, as they are rich in fat, and contain proteins which admit of easy assimilation. It should be noted, however, that the nutritive value of meats of such animals necessarily depends on the breed and the kinds of food they subsist on. Judged by this standard, the meat of Indian animals is not so nutritious as it should be.

Meat is an appetising and stimulating food, but its stimulating effect is of short duration. Its acids and salts facilitate the digestion of protein and render them more easily available to the body. Though meat is considered to be a very valuable food from almost all points of view, there are some dangers involved in over-eating, which must be guarded against. It has a tendency to form uric acid and also to harden the arteries. The intake of too much meat is, therefore, one of the causes of gout, and of premature old age, because a man is considered to be "as old as his arteries". Meat is a highly acid-forming food, and should be taken along with plenty of vegetables and fruits to maintain the alkalinity of blood. It is also heat-producing, particularly when taken in excessive quantity, due to its large fat content and also due to the fact that the high percentage of protein contained in it, has something like a "dynamic action" stimulating the oxidation process in the body. Milk taken with meat coagulates, and is, therefore, difficult to digest. Fried meat is most difficult to digest due to the coating of fat which interferes with the penetration of digestive juices into it.

Decomposition of meat is the result of the activity of microbes floating in the air. It is the by-products of their activity familiarly known as "Ptomaines" that cause the decomposition of the nitrogenous substances of the meat.

Fish

Average percentage composition of some common fish in Bengal:

	Protein	Fat	Minerals
Rohit ..	18·35	7·55	1·40
Vetki ..	16·25	4·10	0·85
Hilsha ..	14·85	9·20	0·95
Mango fish ..	16·75	4·10	0·85
Magoor ..	19·50	0·50	1·20
Koi ..	17·75	0·45	1·00
Tengra ..	17·30	0·30	1·10

Fish falls in the category of "protective" foods. It contains a fair percentage of "good" proteins, and also valuable mineral salts and important vitamins except vitamin C. Fish can be divided into two classes, *viz.*, Lean and Fat. In the lean fish, water varies from 75 to 85 per cent, proteins 12 to 25 per cent, fat 0·8 to 3 per cent, minerals 1 to 1·75 per cent. In the "fat" fish, water varies from 75 to 80 per cent, proteins 10 to 24 per cent, fat 5 to 12 per cent, minerals 0·5 to 2 per cent. The composition of fish also varies with the season. Fish are at their highest state of perfection previous to spawning. They are then fatter and richer in flavour. After spawning they become watery with poor fat content. The extractives which give flavour are less in fish than in meat. Fatty fish like cods, halibuts and sharks, are rich sources of vitamins A and D.

These fatty fish obtain vitamin A in a round-about way. As has been seen, the green plants are rich in carotene (pro-vitamin A). These plants are eaten by small fish which in turn are eaten by big fish. Thus they become the store-house of vitamin A. The two vitamins in question (A & D) are fat-soluble, and, therefore, they are found concentrated in the oils of big fish while they are deficient in lean fish having very little oils. There is, however, no distinction

between fat and lean fish regarding vitamin B. It is more or less present in all sorts of fish. Small fish when taken whole, is an excellent source of calcium and phosphorus which are the ingredients of bones. Sea-fish is a valuable source of iodine. It is believed by some physiologists that the protein of fish is more easily assimilated than that of any other animal flesh and it does not produce uric acid as quickly as that of meat. However, fish is more or less an acid-forming food, and, therefore, a fish diet should be supplemented with vegetables and fruits to maintain the blood in proper condition. Fish are easily perishable, and the fermenting action begins even at as low a temperature as 32°F. The decomposition of fish yields a poison called "Muscarine".

Among the most popular fatty fish in Bengal are Rohit, Katal, Vetki, Hilsha, Chital, Mrigal and Mahashail. They are good sources of protein, fat and vitamin A. Amongst the lean fish may be mentioned the names of Magoor, Koi, Tengra etc. which are very rich in protein, and most easily digested due to small fat content. Therefore, they are an invaluable food during the period of convalesence.

Shell-Fish :—This class includes oysters, crabs, lobsters, shrimps and prawns. They are very difficult to digest, because the flesh being very coarse and dense, the digestive juices cannot act upon it easily. They are apt to cause irritation of stomach and bowels, and sometimes produce cramp and colic, and also skin eruption like nettle-rash. Besides proteins, shell-fish contain a fair amount of carbohydrate unlike other fish and also in some cases, small amounts of that rare mineral—iodine. Although they contain more or less vitamins and mineral salts, they must not be taken as a regular course in the diet. They may be moderately taken only as delicacies and appetisers if necessary, but not too often.

Cod-Liver Oil :—The oil obtained from the liver of the Cod fish, is very rich in vitamins A and D. The liver oil of the Halibut

is another excellent source of these vitamins. In fact, it is much richer in vitamin A than the Cod liver oil. The liver oils of the Shark and Saw-fish, found in Indian waters, also contain these vitamins in abundance. All these oils are the richest sources of vitamin D, and it is for this reason that they are so much valued as a protection against rickets, particularly in countries with poor sunshine.

VEGETABLE FOODS

Cereals

The cereals mean the grains of such grassy plants as are used for food. They are the cheapest kinds of food, and occupy an important place in the national dietaries of the world. Wheat and rice are the most widely consumed of all cereals. The cereals are the chief source of the energy-yielding carbohydrate in the form of starch. They also contain other elements of food in varying quantities, but in small amounts. The proteins of the cereals are not considered to be "good." The cereals are rich in vitamin B, with little or no vitamins A, C, and D. Though they generally contain an abundance of phosphorus, they are poor in calcium, iron, sodium and chlorine. Due to the deficiency of these vital elements of food, the cereals alone cannot give proper nutrition and necessarily they are to be supplemented by other foods of protective nature. High milling of the cereals destroys the little protective elements they have, even vitamin B. Starch of the cereals is not soluble in cold water, but in hot water its cells burst and then it becomes soluble. The kernel of the grain containing starch is made up of a large number of cells, and the walls of each cell contain an indigestible substance called cellulose which requires to be ruptured before its content *i.e.* starch, is made fit for consumption.

Incidentally, it may be noted here that the animal tissues possess no cell-walls, and, therefore, the animal food contains no cellulose.

Rice

Percentage composition :—

		Water	Protein	Fat	Carbohydrate	Minerals
Rice Raw (milled)	...	14·4	6·7	0·7	77·4	0·8
Rice Raw (home-pounded)	...	14·5	6·8	1·4	76·2	1·1
Rice Parboiled (milled)	...	13·3	6·4	0·4	79·1	0·8
Rice Parboiled (home-pounded)	...	12·6	8·5	0·6	77·4	0·9

Rice is the most widely consumed of all cereals. It is the staple food of more than half the population of the world. Like all cereals it lacks protective elements of food. Its protein content is the lowest among the cereals, barring the common Maize, and also its protein cannot be called "good". It has very little fat and is poor in vitamins and mineral salts. While it contains a moderate amount of vitamin B and a small amount of carotene (pro-vitamin A), it is conspicuous by the absence of Vitamins C and D. It is fairly rich in phosphorus, with little or no calcium, iron, and chlorine. Its sodium and potassium contents are also small. To make the matter worse, the modern processes of high milling almost deprive it of the little protective elements it possesses.

The grain consists of three parts—germ or embryo, bran or pericarp, and the inner starch kernel or endosperm. The germ lies at the end of the grain, pericarp is the outer layer of the grain, and the endosperm is the inside part. Most of the mineral salts,

vitamins and proteins are found in the germ and the bran of the grain. High milling results in the loss of the germ and the bran, and with these the loss of most of the vitamins and mineral salts, and also a fair quantity of protein. The vitamin B_1 (Thiamin) rich in all cereals, is most affected by excessive milling, so much so that about 75 per cent of the vitamin is lost. The deficiency of this particular vitamin, as it may be remembered, is the cause of Beri-beri. Hand-pounding also causes the loss of the germ but only a partial loss of the bran. Hence hand-pounded rice is much richer in minerals, vitamins and proteins than the polished rice, and it is noteworthy that the machine-made rice contains only about half as much phosphates as the hand-made rice. It may be mentioned here that the keeping property of the milled rice is superior to that of hand-pounded rice, and the modern marketing condition is more or less responsible for the growth of the popularity of milled rice.

In this connection, a distinction should be made between the par-boiled* rice (Siddha) and the raw rice (Atap). The process of par-boiling requires steaming and this steaming causes the diffusion of vitamins and other nutrients through the grain, driving them from the germ and the bran into the inner parts of the grain. The result is that subsequent milling cannot easily remove these substances from the grain. This fact accounts for the higher nutritive value of the par-boiled rice than the raw rice. It has been proved beyond doubt that Beri-beri and other deficiency diseases are more prevalent among the raw rice-eaters than among those eating parboiled rice. Thus it can be concluded that the hand-pounded parboiled rice is the safest to eat.

We may note here that too much washing of rice is another factor which causes the loss of vitamins and mineral salts, and it

*In making par-boiled rice, paddy is at first soaked in water, and then boiled or steamed, after which it is milled or pounded; par-boiling splits the husk admitting its easy removal.

is the first washing that is responsible for most of the loss. Cooking water (congee) which is generally thrown away, also removes some of the nutrients. It is, therefore, wise to do the least possible washing and boil the rice in the least possible water which should not be thrown away.

Although rice may be called a very deficient food, it is the most easily digested of all cereals, and, therefore, very popular. Its carbohydrate content consisting as it does, of starch, sugar and dextrine, is nice to the palate. The way in which rice is stored has a great influence not only on its nutritive values but also on its digestibility and taste, as proper storage converts a certain portion of the starch into sugar and maintains its vitamins and minerals intact. According to some physiologists, the protein of rice is biologically superior to that of wheat, and, therefore, the difference between wheat and rice in the amout of protein content is not considered to be of much consequence. It may be recalled here that the proteins of the cereals are not so well assimilated as those of the animals. Only a little more than 75 per cent of the protein of rice can be utilised by the body as against about 95 per cent of animal proteins. Rice being defective in protective elements of food must be supplemented by other kinds of food.

Wheat

Percentage composition :—

	Water	Protein	Fat	Carbohydrate	Minerals
Wheat Flour (whole) ...	12·2	12·1	1·7	72·2	1·8
Wheat Flour (refined)	13·3	11·0	0·9	74·1	0·4

Next to rice, wheat is the most important cereal. Like rice it has also got three parts—germ, pericarp or bran and endosperm

or the inside of the grain containing the starchy substance. The germ and the bran contain most of the proteins, mineral salts, vitamins and also a little fat which gives a yellowish colour to the whole wheat flour. Wheat contains the largest amount of protein among the cereals, but there is a difference of opinion among the nutrition workers regarding the quality of its protein. It is rich in phosphorus but poor in calcium, and it contains more iron and manganese than rice. Its vitamin contents are mainly of B group with a small amount of carotene. On the whole, wheat has more of the nutritive elements than rice. High milling is responsible for the loss of the germ and the bran and with these the loss of most of the protective elements of wheat. It is said that about 75 per cent of vitamin B and 50 per cent of phosphorus and manganese are lost in milling, not to speak of other valuable elements. It is for this reason that the whole wheat flour is much more nutritious than the white flour, giving protection against Beri-beri. The whole wheat flour popularly known as "Atta" in India, is made by grinding the grains to powder with the aid of a millstone. In India wheat is generally eaten in the form of "Chappatis" prepared from hand-pounded Atta which contains not only the starchy kernel but also large portions of the bran and the germ. In most of the civilised countries wheat is taken in the form of white flour, made into bread which may very well be called a "starvation" food. Even the wholemeal flour is not a complete food, and it must be supplemented by other kinds of food of protective nature. White flour has the advantage of being more easily digested than the wholemeal flour, with less wastage in the body. It does not deteriorate so easily as the wholemeal flour, and, therefore, it is more popular from the commercial point of view.

Millets :—Grains like Ragi or Okra, Bajra or Cambu, and Cholam or Jowar, are known under the common name Millets. They can be favourably compared with wheat as regards food

contents, but they are cheaper and less popular than wheat or rice, and do not require much rich soil to grow. They generally form the staple food of poor classes in some parts of India. The millets are very small grains eaten with the brans remaining intact, and naturally they contain more vitamins and minerals than white rice or white flour. Though they are less easily digestible than wheat and rice, they are good supplementary foods particularly for poor rice-eaters who cannot have much "protective" foods from other sources. They are much superior to rice, as far as vitamin, iron, and fat contents are concerned, and are a good protection against Beri-beri due to their being fairly rich in vitamin B. Among all the cereals, Ragi is the richest source of calcium, and for this particular property, it may be taken with advantage along with other cereals.

Bread :—Bread is prepared by making the flour into dough, and then baking it. It is the gluten—the protein element of flour—that gives the tenacious character to dough. Rice being poorer in gluten, cannot be made into dough and bread. The spongy character of bread is produced by fermentation for which yeast is used. The activity of yeast causes the production of alcohol and carbonic acid gas, and while the carbonic acid gas disappears quickly, the alcohol disappears slowly as the bread gets stale. Fresh bread is not a desirable food to eat not only because it contains too much alcohol, but also because it is difficult to digest, as its gluten and starch are soft and not so porous as to allow the digestive juices easily penetrating into the mass. The toasted loaf is easier to digest than the untoasted one, because it is not only porous, but also in the process of toasting much of its starch becomes converted into dextrose.

It is needless to mention that the wholemeal flour bread has more nutritive elements than the white flour bread; but the former

having coarse particles of bran, is more difficult to digest than the latter. The wholemeal bread contains a little more protein and fat than the white bread. Besides, it contains vitamin B, phosphorous, calcium, iron and manganese, which the white stuff lacks. It is held by some nutrition workers that the deficiency of vitamin B in the white bread is made up to a great extent by the addition of yeast which is very rich in this vitamin. But it must be remembered that the amount of yeast used in making bread is so small that this factor can be more or less ignored. Malted bread in which the starch is converted into maltose under the influence of a peculiar ferment called "diastase" produced in the coating of the seed during germination, is naturally the most easily digested of all varieties of bread. In England and America the white flour bread is now reinforced with synthetic vitamins to bring it near to the composition of the wholemeal bread, as far as vitamins are concerned.

Suji or Semolina:—Suji consists of the hard particles of the wheat gram, which do not pass into flour in milling. These particles are separated after grinding, and used as food. Suji contains a high percentage of protein, and is very rich in vitamin B. It is a good supplementary food particularly as a protection against Beri-beri.

Oats

Percentage composition:—

	Water	Protein	Fat	Carbohydrate	Minerals
Oatmeal ...	10·7	13·6	7·6	62·8	1·8

This cereal is quite rich in fat, and is, therefore, a suitable food for those living in cold or temperate climate. It also contains a fair amount of protein but not of "good" type. It has a small amount of carotene with little or no vitamin C, but is quite rich

in vitamin B. It contains valuable mineral salts, the bulk of which is potash and phosphorus. Iron which is so rare an element, is present in oats in moderate quantity. Although oatmeal is a very nutritious food on account of its fat, protein and mineral contents, it should form a supplement to other foods in view of its deficiency in such protective elements as vitamins A, C and D.

Oatmeal is chiefly taken in the form of porridge. It is made by stirring the meal into boiling water. At first the water is boiled and then the meal is added to it which should be continuously stirred. The mixture is boiled for about 20 minutes by which time it becomes thick. The proportion of the meal and water should be about 1 to 5.

Barley

Percentage composition :—

	Water	Protein	Fat	Carbohydrate	Minerals
Barley	12·5	11·5	1·2	69·3	1·5

Barley possesses about the same amount of protein as wheat. It more or less contains almost all the important mineral salts. It is specially rich in phosphorus, potassium and manganese, and is a good source of vitamin B with little or no vitamins A & C. The finest form of barley is Pearl Barley. It has less protein and less fat, but generally more starch and minerals than other forms of barley. As it is poorer in gluten than wheat, the flour is not easily made into bread. Barley is used in the preparation of liquid diet for invalids.

Maize

Percentage composition :—

	Water	Protein	Fat	Carbohydrate	Minerals
Maize	14·9	11·1	3·6	66·2	1·5
Maize flour	11·5	0·6	0·5	87·0	0·4

Maize contains nearly as much food elements as wheat, except that it is richer in fat. It has a fair amount of vitamin B_1, with a trace of carotene. The yellow variety is richer in carotene than any other cereal. It contains many valuable mineral salts, and is particularly rich in phosphorus and potassium. One of the great defects of Maize is that its protein is of very inferior quality. Also it is devoid of vitamin B_2 complex, and it is due to the absence of a particular vitamin in this group *viz.*, nicotinic acid, that the maize eaters of Italy and Balkan Peninsula are so prone to be afflicted with that serious "deficiency" disease known as Pellagra. It is, therefore, dangerous to eat maize as a staple food without supplementing it with some other cereals like wheat, rice, etc.

Farinaceous foods

Farinaceous foods are those which consist mostly of starches varying from 70 to 85 per cent. They contain very little of other elements of food including protein. Among the pure starchy foods, Sago, Arrowroot, Corn-flour, Tapioca, are most popular. Starch granules consist of two layers—granulose and cellulose. It has been noted before that Cellulose is insoluble, and a starchy food necessarily requires boiling for causing the rupture of the cellulose, and making the food fit for consumption. Being extremely poor in the vital elements, the farinaceous foods are of no use to the body except for providing heat and energy. Therefore, they cannot alone constitute a man's diet, and must be supplemented with other compensatory foodstuffs containing body-building and protective elements.

Sago

Percentage composition :—

	Water	Protein	Fat	Carbohydrate	Minerals
Sago	12·2	0·2	0·2	87·1	0·3

It is derived from the pith of the Sago Palm. The trees are cut down just before the appearance of the flower-bud, and the pith extracted. It is at first reduced to powder and then washed and strained. The sediment, when dried, is the sago flour. The starch of sago is most easily digestible and is a bland food suitable for invalids.

Arrowroot

Percentage Composition :—

	Water	Protein	Fat	Carbohydrate	Minerals
Arrowroot	16·5	0·2	0·1	83·1	0·1

The starch is obtained from the root of a plant which grows wild in the West Indies. The roots when about a year old, are dug up, washed and then mixed with water. The sediment is next dried to form arrowroot. It is also a bland food like sago, suitable for invalids. The arrowroot is so called because the West Indians believed that the roots had a healing effect upon the poisonous wounds caused by an arrow. Not all the arrowroots sold in the market are derived from the same source. Many are prepared from the starches of Maize, Tapioca, Potatoes, etc. Farina or English arrowroot is generally potato starch.

Cornflour :—It is a starchy food prepared from Maize. In the process of preparation the protein is mostly eliminated.

Tapioca :—It is derived from the root of a plant named Cassiva growing abundantly in South America. It is mainly a starchy food containing about 85 per cent starch with traces of protein, fat and mineral salts. It is now being grown in South India, and the Cochin State has taken the lead in its cultivation. The calories provided by an acre of land are 2,900, and the caloric value per 100 grammes of Indian Tapioca is estimated to be about 160.

Sugar

In the ordinary sense, by sugar we understand only cane and beet sugars. But the term has a wider significance, as it covers not only sucrose, but also maltose, lactose, glucose or dextrose, laevulose or fructose. The two principal forms of sugar are, however, sucrose and glucose. The sugar derived from canes and beets, is called sucrose and that derived from fruits, laevulose or fructose, and that from grapes, glucose. Sucrose can also be derived from the juices of the date, cocoanut, and palmyra trees. All the different forms of sugar, as has already been seen, have to be converted into glucose before they can be absorbed into the system. Sucrose is converted into glucose under the action of a ferment called invertase in the Small Intestine. Starch is at first converted mainly into dextrin under the action of the ptyallin of saliva, then into maltose under the action of amylopsin of the pancreas, and finally into glucose in the Small Intestine. The same transformation of starch into maltose and dextrin is also effected by a ferment called diastase formed during the germination of cereal grains. Lactose is the milk-sugar which occurs in the milk of all animals, and it is also converted into glucose in the Small Intestine. Glucose generally undergoes ready fermentation, and when treated with yeast, it is immediately transformed into alcohol and carbonic acid gas. Other forms of sugar, however, require to be primarily converted into glucose for the purpose of such fermentation.

Sugar is only an energy-yielding food. It is devoid of any protein, fat, mineral salts and vitamins. Common sugar (Sucrose) is an acid-forming food, and is, therefore, harmful to take too much of it. When taken in excess it generally causes the loss of appetite and produces toxic acid. It is believed that too much white sugar in the diet is responsible for dental diseases. In Western countries the dental diseases are more common than in

Eastern countries, and this is accounted for by the fact that the people of these countries take sugar more freely than those of Eastern countries.

Jaggery (Gur)

It is the last mother liquor left as a by-product in the manufacture of sugar from sugarcane. Gur is also prepared from juices tapped from the date, the cocoanut and the palmyra trees. It contains a small amount of carotene and also some mineral salts including iron and is, therefore, more valuable as food than white sugar.

Average percentage of Sucrose in Jaggery from various sources :—

Cocoanut	...	...	...	85	per cent
Palmyra	...	...	...	82	,,
Sugarcane	...	...	...	70	,,
Date palm	...	...	...	55	,,

Honey

Honey is the nector drawn by the bees from the base of the petals of flowers. It is stored by the bee in its stomach known as the honey bag where it undergoes a partial digestion before being deposited in the hive. Though it is a mixture of various kinds of sugar including sucrose, glucose and laevulose, the bulk of the sugar is present in the form of laevulose and glucose.

The quality and flavour of honey depend upon the nature of the plants from which it is obtained. Honey is not so easily fermented in human stomach as ordinary sugar, and is more readily absorbed into the system due to its being partially digested by the bees. It is, therefore, a suitable sweet for invalids and convalescents. It contains traces of protein, mineral salts and vitamin C. It possesses some medicinal values. It is a stimulant to heart and slightly laxative, and is beneficial in cough and cold.

Legumes or Pulses

Percentage composition :—

	Water	Protein	Fat	Carbohydrate	Minerals
Lentil (Masur) ...	12·4	25·1	0·7	59·7	2·1
Green Gram (Mung)	10·4	24·0	1·3	56·6	3·6
Red Gram (Arhar) ...	15·2	22·3	1·7	57·2	3·6
Peas dried ...	16·0	19·7	1·1	56·6	2·1
Peas green ...	80·0	6·0	0·4	12·0	0·6

The protein of pulses is called legumin, and, therefore, pulses are called leguminous seeds. Dals, peas and beans belong to this order. The comon characteristic of legumes is that they are very rich in protein, even richer than meat or fish. But their proteins are not so "good" as those of meat, fish, milk, eggs etc. In other words, the biological values of the proteins of pulses are inferior to those of animal foods, and, therefore, a much lower percentage of their proteins is available for nutrition, and their digestion also involves a considerable waste of energy. The pulses more or less contain some valuable mineral salts, and are particularly rich in potassium and phosphorus. Some varieties of pulse are good sources of iron *e.g.*, Green gram (Mung), Red gram (Arhar), Bengal gram (Channa). The proteins of Red gram and Bengal gram are said to be biologically superior to those of any other grams, and, therefore, they are considered to be most nutritious among the pulses. Next in order comes green gram. Most of the popular pulses are rich in vitamin B_1 and also contain a moderate amount of carotene. They lack vitamin C, but when they are allowed to sprout, vitamin C is formed in the grains and the green shoots. The food values of the pulses depend very much on the way they are cooked. When they are baked into "Chappatis" or cakes, they provide more nutrition than when they are cooked in water. It is believed that in the form of cakes more than 90 per cent of the protein is utilised by the body as against

50 per cent on an average, when boiled in water. When cooked in hard water they become very difficult to digest. Any addition of baking soda to hasten boiling, causes loss of vitamins and probably some salts. Due to their being rich in Vitamin B_1, pulses are considered to be a protection against Beri-beri. The cellulose present in pulses is not easily soluble, and, therefore, too much intake of pulses is harmful to the system. They have a tendency to cause flatulence and colic, and also formation of uric acid. They are supposed to contain a poisonous substance called Xanthaline, and it is said that gout which is a common complaint among the pulse eaters of India is caused not only by the deposit of uric acid in the system but also by the presence of Xantheline. Dal and rice are a good combination in dietaries, provided they are supplemented with some protective foods like milk, meat or fish. When a diet consists mainly of rice or wheat and dal, an average person should not take more than four ounces of dal. McCarrison says that in a dal and rice diet these two foodstuffs should be taken in proportion of 1 to 5.

It should be noted that peas and beans in dried condition are many times richer in food values than in fresh condition, although the latter type is more tender and digestible. Pea-meal made into porridge is a nutritive food with milder action on the stomach than any other preparation.

Soya Beans

Percentage Composition :—

	Water	Protein	Fat	Carbohydrate	Minerals
Soya Bean ...	8·1	43·2	19·5	20·9	4·6

The Soya Bean is considered to be the best of all pulse foods. It is very rich in protein and fat, particularly in dried condition, and its protein is said to be much superior to the proteins of other

kinds of legumes and also of cereals. In fact, it is believed by some physiologists that its protein can very well be compared with the animal proteins. It is a good source of vitamins A and B. It contains many of the important mineral salts, and is particularly rich in phosphorus, calcium and iron. Due to its high nutritive value the Soya Bean is a good supplement, particularly to the diets of the vegetarians, and also of the poorer classes who cannot afford costly protective foods. The Soya Bean is a very popular food among the Japanese and the Chinese, but they take it in the form of sauces and other preparations to make it palatable. It is the considered opinion of many nutrition experts that the Soya Bean milk properly prepared is a very suitable food for infants. The Bean possesses some unpleasant aromatic substance which must be removed before it can be relished like pulses. The Nutrition Advisory Committee to the Govt. of India rules out the possibility of its consumption on a wide scale, as they think it cannot replace pulses which are so favourite among the Indians. However, if it can be popularised, it will neutralise to some extent the deficiencies of the diets of the poorer section of Indians. Besides its food value, the Soya Bean has many industrial uses due to its rich fat content.

Vegetables

The main characteristic of vegetables is that they generally contain a very high percentage of water varying from 75 to 95 per cent. They possess very little body-building and energy-bearing elements, *viz.*, proteins, fats and carbohydrates. Their proteins, however, are better than those of cereals and pulses, and it is considered by some physiologists that they are nearly as good as those of animal proteins, particularly the proteins of leafy vegetables. The carbohydrate of vegetables more or less exists in the form of sugar, and therefore, it is easily absorbed. Poor

as they are in proteins and carbohydrates, the values of the vegetables lie in their being rich in the protective elements of food, *viz.*, minerals and vitamins. Vegetables are, therefore, an indispensable supplement to staple foods like wheat, rice etc. which are poor in these protective elements.

Due to their having abundance of mineral contents they generally help to maintain the alkalinity of blood. Almost all our common foods including meat, fish, pulses, are acid-forming, and hence the necessity of taking plenty of vegetables becomes imperative. An average person should take at least 8 ozs. of vegetables daily.

Vegetables are broadly divided into two classes, *viz.* (1) Roots and tubers, (2) leafy vegetables. Besides these, there are stem vegetables like mushrooms, asparagus, celery etc., and fruit vegetables like Brinjal, Pubul (Patal), Ladies finger, Gourd, Cucumber etc. Season, soils, methods of cultivation and manuring are amongst the factors which determine to a great extent the nutrients of foods of vegetable origin.

Root vegetables contain a fair amount of starch and sugar. Vitamins B and C are present in a moderate quantity, but there is little or no carotene except in those that are of yellow colour like carrots and sweet potatoes. They are generally rich in mineral salts, though containing less calcium and iron than the leafy vegetables.

Leafy vegetables are more valuable than the roots and tubers, inasmuch as they contain abundance of mineral salts and vitamins. The leaves of the green vegetables are considered to be their livers and lungs, and naturally they are the storehouses of these vital elements. Leafy vegetables are particularly rich in vitamins A (carotene), B and C, and also calcium, iron and potassium. Due to the presence of vitamin C the vegetables are a protection against scurvy. This vitamin is very sensitive to

heat, and this fact should be borne in mind when cooking the vegetables. They should be cooked quickly in covered saucepans in as little water as possible, and this will entail minimum of waste. To be on the safe side, a certain quantity of salads should form the part of the daily menus. The valuable minerals of green vegetables generally lie close to the skin, and, therefore, they should be pared thinly to avoid waste. Leafy vegetables contain a frame-work called "roughage" which is not absorbable. It is, however, useful, as it gives the digestive canal its "daily scrubbing", and also stimulates the action of the bowels.

Vegetable Juice :—It has hardly any equal in revitalising the system due to the presence of vitamins and minerals in their best form. It often works miracles in cases of nervous break-down, heart diseases, high blood-pressure and Diabetes Mellitus.

Roots and Tubers

Percentage Composition :—

	Water	Protein	Fat	Carbohydrate	Minerals
Potato ...	74·7	1·6	0·1	22·9	0·6

Potatoes :—Potatoes have been adjudged by the Health Committee of the League of Nations (now defunct) as an important protective food, and they recommend a more liberal intake of potatoes in the diet. They are a valuable source of iron, rich in vitamin C, and contain more vitamin B than milled cereals. Among the vegetables, the potatoes have the peculiarity of retaining a high proportion of vitamin C after they are cooked. They provide more easily available calcium and phosphorus than the cereals. They are rich in potassium; and as potassium has greater affinity for chlorine than sodium, it readily transforms much of the sodium chloride of the blood into potassium chloride, and this means the loss of sodium chloride to a great extent. Hence it is necessary that sufficient common salt should be added to a potato diet. Due

to the presence of mineral salts in abundance and also vitamin C, the potatoes are a good protection against scurvy. The mineral salts together with a little citric acid present in potatoes help to maintain the acid-base balance of the blood. Potatoes are fairly rich in starch which is considered to be the most easily digestible of all starches. This starch is not acidifying, and does not show any predisposition to cause dental diseases like the starches of cereals, or the common sugar. The little protein it contains is considered to be "good". Dehydrated potatoes, concentrated as they are, possess a much more nutritive value than fresh potatoes, weight for weight. It should be remembered that the nutritive values of potatoes very much depend on the quality of the soils and seeds and also the methods of manuring and cultivation.

Potatoes contain an alkaloid but in such a small quantity that it is practically harmless. It can be extracted by boiling, and even destroyed. The alkaloid is present in a large quantity in sprouting potatoes, and, therefore, it is advisable to cook young potatoes after peeling out the skin. The old potatoes should, however, be boiled in skins for making the best use of the protective elements. New potatoes contain more vitamin C and more sugar but less starch than old potatoes. Potato leaves and flowers are more or less poisonous.

Potatoes are not only nutritious but also an economy crop, as it is estimated that an acre of land under potato can support a larger number of people than an acre of land under wheat or rice. It is found that an acre of land under potato yields about 50 maunds while an acre of land under wheat or rice yields about 10 maunds, and on the basis of these figures it is estimated that the calories provided by an acre of land under potato and by an acre of land under wheat or rice are about 1800 and 1300 respectively. The caloric value of 100 grammes of potato is in the neighbourhood of 100.

Sweet Potato

Percentage Composition :—

	Water	Protein	Fat	Carbohydrate	Minerals
Sweet Potato ...	66·5	1·2	0·3	31·0	1·0

The composition of sweet potatoes is almost the same as ordinary potatoes, but they are less easily digestible than the latter due to the presence of fibres. They are a little richer in carbohydrate and sugar contents, but poorer in vitamin B than common potatoes. The yellow and red varieties contain a small amount of carotene. The calories provided by an acre of land under sweet-potatoes are about 3900. Therefore they are even more valuable than common potatoes from the economic point of view. The caloric value of 100 grammes of sweet potatoes is estimated to be about 130.

Carrots :—The carrot is poor in body-building and energy-yielding elements, but it is rich in mineral salts and also vitamins A (carotene), B and C Its special value lies in the fact that when yellow it becomes rich in carotene (pro-vitamin A) from which vitamin A is synthesised in the body. When externally applied the carrot has the healing effect on sores. It is believed by many that the carrot juice is sometimes effective even in internal sores.

Beet-roots :—The bulk of the carbohydrate in beet-roots is found in the form of sugar. It is for this reason that they are grown chiefly for the purpose of manufacturing sugar. They are rich in minerals and contain vitamins B and C with a trace of carotene.

Radishes :—The radish is less digestible than other kinds of root-vegetables on account of its tough fibres. It is poor in major elements of food, but is rich in minerals, and contains vitamins B and C. It stimulates digestion and is considered to be antiseptic in the intestine. It contains a trace of arsenic and is believed to give relief in Diabetes Mellitus.

Turnips :—Turnips are rich in mineral salts and contain vitamins B and C. But for these elements, the turnip has very little value as food. It possesses a pungent essential oil.

Colocasia (Kachu) :—It is an energy-producing food containing a fair percentage of carbohydrate and also a small amount of protein. It contains a fair amount of iron and many other minerals It is a good source of vitamin B, having a moderate amount of carotene with a slight trace of vitamin C.

Onions and Garlics :—Both onions and garlics belong to the same order. They are good sources of vitamins B and C with little or no carotene. They contain all the important mineral salts in moderate quantities. They are rich in sulphur, and possess a volatile oil which gives a pungent taste and the peculiar smell. The oil is stimulating and irritating in its action. Both onions and garlics have antiseptic properties, reducing intestinal putrefaction. Garlic has been found to be very beneficial in pulmonary diseases. They are useful adjuncts to food, and more so owing to their therapeutic values. But they should not be taken too freely owing to their stimulating and irritating actions.

Rhubarb :—It is not only appetising but also digestive. It has laxative and cleansing properties, and has an acid flavour which is refreshing. It contains vitamins A (carotene) and C in small amounts, and many important mineral salts including iron.

Fruit Vegetables

Cucumber, Pumpkins, Gourds, Melons, Brinjals etc :—These vegetables form a class by themselves. They have little nutritive values. They generally contain small amounts of vitamins B and C, and also mineral salts. They are difficult to digest owing to their fibrous structures. But they are useful when taken in moderation, inasmuch as they provide bulk to the diet, and break its monotony. The cucumber has a small percentage of sugar, and

a ferment which aids digestion of other foods. It is believed by many that the free use of cucumber sometimes causes nettle-rash.

Leafy Vegetables

As has been already pointed out, the leafy vegetables have very little body-building and energy-bearing elements, but they are very rich in vitamins and minerals. Hence they occupy a high rank among the protective foods. Tender leaves are in most cases richer in vitamins and minerals than mature ones. Generally the outer parts of leafy vegetables which are fully exposed to the sun and air, possess more nutrients than the inner parts. Many of them contain essential oils which impart to them a peculiar flavour. A fair proportion of carbohydrate in most of them is in the form of sugar which is readily absorbable. Many of the leafy vegetables contain more or less iodine.

Cabbage and Cauliflower :—They are rich in mineral salts, especially calcium and potassium. They are also good sources of iron. Both of them contain an abundance of vitamins B and C, but the cabbage is exceptionally rich in carotene, while the cauliflower possesses a small amount.

The green outer leaves of the cabbage contain more carotene than the inner parts. The cabbage is fairly hard to digest, and its sulphur content is apt to form sulphuretted hydrogen in the bowels, causing offensive flatulence. The cauliflower is easier to digest than the cabbage.

Spinach :—It is very rich in vitamins A (carotene), B and C and also minerals, unrivalled by any other vegetables. But it contains a large quantity of oxalates, and, therefore, it should be taken in moderation, particularly by one with weak liver. It is a very good source of iron, and is, therefore, effective in cases of anaemia. It is said that its calcium content cannot be well utilised by the body.

Puin Sag :—Belongs to the same species as spinach, hence it is called Indian Spinach. The entire herb—roots, stalks, and leaves are eaten. It is rich in vitamins A (carotene), B and C and also minerals, particularly iron. It is a wholesome food and very easily digested. It acts as a mild laxative.

Celery :—It is a flavouring vegetable used as a salad, It is appetising and carminative. It possesses an essential oil which gives the flavour. It contains important minerals, and is rich in carotene with fair amounts of vitamins B and C.

Lettuce :—It is widely used as a salad owing to its crispness and high percentage of water contained in it. The salad is palatable, cool, refreshing and sedative inducing sleep. It is rich in mineral salts and vitamins, particularly carotene. It should be kept in water which it readily absorbs, thus retaining its juice.

Tops of Radish, Beet-root, Turnip and Onion :—Like all leafy vegetables these tops contain more or less carotene, though their roots have practically none. They are all rich in mineral salts and also vitamins B and C. The turnip tops are particularly rich in calcium and iron.

Water-cress :—This herb generally grows along shallow streams with sandy beds. It is rich in minerals and vitamins. It is a good source of iron, and possesses an essential oil which imparts to it a peculiar flavour.

Parsley :—It is particularly rich in iron, and contains an essential oil which gives the peculiar flavour. It is a very good source of carotene and vitamin C.

Leaves of Amarnath, Fenugreek, Corriander, Neem (tender), Ipomea, Mint and Drumstick :—These are amongst the most important Indian leafy vegetables, the dietetic values of which are not fully appreciated. They are all rich in vitamins, and mineral salts, particularly carotene and calcium.

Lucerene (Alfalfa) :—Lucerene is popularly known as Alfalfa, the name given by the Moors, meaning "best fodder". It was originally used as fodder, but recent researches have found out its invaluable properties as a food for human consumption. It possesses quite a fair amount of "good" protein with its calcium, iron, copper and manganese contents being remarkably high. The abundance of these minerals has given it a therapeutic value as a good tonic. It is exceptionally rich in vitamins A (carotene), B and C. It is said that fresh Alfalfa contains three times as much calcium as milk, twice as much iron as spinach; and as to vitamin C, the fresh juice contains five times as much vitamin C as the orange juice of same quantity.

Vegetable Oils

Oils are extracted from many vegetables including fruits, *e.g.* olives, nuts, soya beans, cotton seeds, mustard seeds, linseeds, rape seeds, cucumber seeds, and various tubers. These oils are sources of heat and energy only, without any other nutritive principles. They lack vitamins and mineral salts. The fats like butter, ghee, cod-liver oil are rich in vitamin A, but the vegetable oils contain none. In their fresh condition they may have often a little of this vitamin, but when they are converted into vegetable ghee and butter like Cocogem, Vanashpati and Margarine by hardening process, there is left hardly any trace of this vitamin.

Olive Oil :—Fats with lower melting points are more easily digested, and, therefore, oils extracted from olives, peanuts and soya beans may be freely used with beneficial results. Particularly the olive oil is a pure bland oil which is not only useful for domestic purposes but also for various gall-bladder complications. The first instalment of oil extracted from the ripe fruit is known as the virgin oil. It is greenish in colour, and is more effective.

Peanut Butter :—It not only contains fat but also a high percentage of protein. It is said to contain a fair amount of vitamins A and B.

Margarine :—Though this fat is mainly of vegetable origin containing no vitamins by itself, it is considered as a good substitute for butter owing to the addition of vitamins A and D in the present-day preparations. It is manufactured from various animal fats, chiefly from whale oil, and also from oils of plants. Its fat and water contents are almost the same as in butter.

Red Palm Oil :—This oil is extracted from the fruit of the tree which is a native of West Africa, Malaya and Burma. It is exceptionally rich in Carotene and is said to have been used with success as a substitute for cod-liver oil, as far as vitamin A is concerned. This oil may be mixed advantageously with other oils of vegetable origin to re-inforce them with vitamin A.

Fruits

Fruits contain a very high percentage of water varying from 80 to 85 per cent. Like leafy vegetables they have little body-building and energy-yielding elements. But they are very rich in minerals and vitamins, and as such, they are placed alongside the best of "protective" foods. They contain a considerable amount of fruit sugar known as Laevulose or Fructose, but the sugar content varies with the degree of ripeness. In the unripe condition, starch rather than sugar is present, but during the process of ripening starch begins to decrease until it is wholly converted into sugar.

Fruits contain valuable organic acids which together with the vitamins and minerals, maintain the tone of the system. Paradoxical as it may seem, these acids help to maintain the alkalinity of blood. They are considered to be solvents of uric acid, and it is for this reason that the fruits are so beneficial in gout.

The free acids of fruits also help to diminish the acidity of the urine.

Fruits possess a substance called Pectin which has the property of forming jelly in combination with water, sugar and acids of the fruits. They also contain many ferments in the natural state, which stimulate the digestion of other foods. Fruits are very valuable for their soothing influence on nerves, and for protection against "deficiency" diseases, particularly Scurvy, due to their being rich in vitamin C. The calcium salt of fruits generally holds on to the fibrous structure, and hence the intake of a boiled fruit gives more calcium than the juice extracted from it. When fruits are over-ripe, they become fermented. Such decomposed fruits are dangerous to eat, and should be avoided at all costs. The flavour of the fruits is caused by the essential oil present in them.

Organic Acids :—The three organic acids, *viz.*, Citric, Malic and Tartaric consist of Carbon, Hydrogen and Oxygen, and are more or less oxidised in the body like starch and sugar. It is said that in the process of oxidation they leave a residue mainly of potash forming potassium bicarbonate. Thus although the fruits apparently have an acid reaction, the ultimate reaction is alkaline. On the other hand, the citric acid is considered to be capable of maintaining the fixed acid of the blood when it becomes too alkaline. The alkalinity depends upon the degree of oxidation of the acids. There is a difference of opinion among the physiologists regarding the reaction of Tartaric acid, but most of them agree as to the alkaline reaction of citric and malic acids, provided they are fully oxidised. Many of the fruits, however, are not alkaline in reaction due to the presence of some harmful acids. Thus fruits like plums, prunes, cranberries etc., are acid-forming due to the presence of an abnormal amount of quinic acid.

Fruits Containing Citric Acid :—Lemons, Oranges, Grape-fruits, Pomeloes, Limes, Pears, Pomegranate, Strawberries, Rashberries, Cherries, Currants, Tomatoes etc.

Fruits Containing Malic Acid:—Apples, Pears, Peaches, Plums, Cherries, Currants, Grapes, Strawberries, Tomatoes etc.

Fruits Containing Tartaric Acid:—It is abundantly found in grapes with traces in many other fruits.

Apples:—Among the fruits the apple occupies a unique place. Its many-sided benefits are universally admitted, and have given rise to the proverb "An apple a day keeps the doctor away". The apple contains vitamins A (carotene), B and C in small amounts, and more or less all the important mineral salts. Its sugar content is higher than any other wholesome fruit except grapes, and it may, therefore, be called one of the best energy-yielding fruits. The natural acid of the apple, *viz.*, malic acid, is antiseptic for teeth, stomach and intestine. The acid and the minerals help to maintain the alkalinity of blood. The apple has a laxative action, and is good for those suffering from habitual constipation. It may be taken both raw and boiled, and when boiled it is more easily digestible.

Pears, Plums, Peaches:—These fruits belong to the same order as apples, and have the same chemical composition, containing malic acid.

Oranges, Lemons, Grape-Fruits, Pomeloes (Batabi):—These fruits are commonly called citrus fruits due to the presence of citric acid in large quantity. All of them are very rich in vitamin C, and hence the most valuable protection against Scurvy. They also contain vitamins A (carotene) and B, and all the important mineral salts. The acid exists partly as citrate of potash, and partly as free acid. The fruits are invaluable as solvents of uric acid, and are thus beneficial to those suffering from gout. The peels of oranges are used for preparing Marmalade. The marmalade is laxative, and is particularly useful in intestine troubles. The rind of a lemon contains a non-acid essential oil which is separated as essence of lemon.

Tomatoes :—In the ordinary sense, the tomato should be included in the vegetables, but in view of its invaluable properties which are very much akin to those of citrus fruits like lemons, oranges, etc., it is now treated as a fruit. As the result of recent investigations, the tomato is considered to rank amongst the best fruits in the science of nutrition. It is rich in vitamins A (carotene), B and C, and also in mineral salts. It contains both citric and malic acids which are ultimately converted into powerful alkaline salts. It is undoubtedly an excellant solvent of uric acid, and is thus a remedy for gout. In view of its high vitamin contents, particularly B and C, it is a sure protection against Scurvy and also Beri-beri. It has the peculiarity of maintaining the bulk of its vitamin C even after cooking. The carotene is absent in green tomatoes, but it is formed when the fruit turns yellow or red. The recent improvements in gardening have reduced the sourness of the fruit, and it is now more palatable and easily digested. The tomato or orange juice should be given to a child not before the lapse of at least 20 minutes from feeding, as its acid may coagulate the milk.

Grapes :—The grape contains a large percentage of sugar, and occupies the position of pre-eminence among the fruits from the point of energy-yielding power. The sugar is in the form of glucose which is readily absorbed. The grape is poor in vitamin content with little or no vitamins A (carotene) and C. It is fairly rich in vitamin B and the important mineral salts. The acid of the grape is tartaric and exists partly in the form of tartarate of potash, and partly as free acid. It acts both upon the kidneys and the bowels with a stimulating effect, and has an antiseptic property. Raisins and Sultanas are grapes in dried condition. They possess very high caloric values with the sugar contents varying from 50 to 75 per cent. The combination of almonds and

raisins in a diet has a significance, inasmuch as the almonds are rich in protein and fat which the raisins lack.

Pineapples :—The pineapple is an excellent fruit particularly noted for a special ferment which converts protein into peptone. Therefore it proves beneficial to one with weak digestion, particularly after the intake of protein foods like meat, fish, pulses etc. The pine-apple is rich in vitamin C, and mineral elements. It contains a large amount of chlorine which helps in the formation of hydrochloric acid, the most valuable ingredient of the gastric juice. It stimulates the kidney function, and also helps to eliminate waste products from the body, particularly due to the presence of chlorine which is figuratively called the "laundryman of the body". The pineapple possesses a large percentage of sugar with a higher caloric value than many of the fruits.

Amla or Amlaki (Indian Gooseberry) :—It is particularly rich in vitamin C, and has hardly any equal in this respect among fruits. It is said that a small amla contains twice as much vitamin C as a big orange. Its acidity possesses the property of preserving vitamin C, and hence the vitamin content is not much lost by heating or drying in the sun. The fruit is considered to be the best protection against Scurvy. A simple way of preserving Amla is to mince the fruit and dry it quickly in the sun, after which the pulp is powdered. As heat and moisture affect vitamin C, it should be kept in a cool and dry place.

Berries :—In this order, fruits like Strawberries, Gooseberries, Blackberries, Currants etc. are included. The common characteristic of these berries is that almost all of them are rich in vitamin C and minerals. Thus, they are a protection against Scurvy. They are considered to be excellent agents in clearing the blood of its toxins. All of them have laxative properties. The strawberry which contains both citric and malic acids, has been found to be useful in cases of Gout and Sciatica.

Papaya:—The papaya is a very useful fruit from the point of digestion. It contains a peculiar ferment called "papain" which converts proteins into peptones. The papain is also believed to have the power of converting starches into sugars, and facilitating emulsification of fats. This ferment is present not only in the fruit but also in the trunk and leaves of the tree. The fruit contains vitamins A (carotene), B and C and is a good source of many important mineral salts.

Green Papaya:—The green papaya has all the properties of the ripe one except that it is poorer in carotene content, and when properly boiled, it proves effective in cases of weak digestion.

Plantains (Bananas)

Percentage composition:—

	Water	Protein	Fat	Carbohydrate	Minerals
Plantain (ordinary)	73·4	1·1	0·1	24·7	0·7

The distinguishing characteristic of all kinds of plantains is that they are rich in starch and sugar contents with high calories. The caloric value of 100 grammes is about 110. In the unripe state, only starch is present, but during the ripening process the starch is converted into sugar. Plantains are very easily digestible, particularly when they are ripe. The starch of plantains is one of the best digestible starches, equalling that of potatoes, and hence they are very nutritious even in unripened state. Plantains combined with milk nearly form a complete diet, and is considered to be the best tolerated of all foods. They have an antiseptic action on the intestines, and are effective in reducing the acidity of urine. They are a good source of the valuable mineral elements, and contain vitamins A (carotene) and C in moderate quantities with a trace of vitamin B. It is said that a mono-diet of plantains is sometimes beneficial in cases of Arthritis. The plantain heals

the list of such economy crops, as potatoes, sweet potatoes etc. The calories provided by an acre of land are about 5,040 as against sweet potatoes 3,900 and common potatoes 1,800.

Mangoes :—The mango contains vitamins A (carotene) and C. It is a rich source of carotene which grows as it ripens. It contains a fair amount of sugar when ripe, and is a good source of mineral salts. Due to its fibres it is not very easily digested, and should not be taken in large numbers at a time.

Jack Fruits :—The jack fruit is a moderate source of carotene with a trace of vitamin C, and contains mineral salts. The flesh of the ripe fruit is easily fermented, and should be taken soon after the fruit is opened. The practice of eating it several hours after opening is attended with great risk, and is often the cause of painful disturbance in the stomach. Exactly similar risk is involved in eating an over-ripe fruit. In any case, the fruit is difficult to digest and should not be taken too freely. The curry made with green jack fruit is also difficult to digest on account of its dense fibres, and hence it should not form part of the menus too often, particularly in the case of people with weak digestion. It is also an acid-forming vegetable and its excessive consumption is distinctly harmful.

Dried Fruits

Dried fruits generally comprise Dates, Figs, Prunes, Plums, Raisins, Sultanas, Bananas etc. They contain a very high percentage of carbohydrate in the form of sugar, varying from 70 to 80 per cent. Thus they are mainly energy-yielding foods like cereals. They are rich in mineral salts, and contain more or less vitamins A (carotene) and B, and thus they may be placed in the category of "protective" foods. Almost all of them have laxative properties.

Dates :—The date is particularly an energy-yielding fruit with a high percentage of carbohydrate in the form of sugar. The caloric value of dates is almost as high as that of rice and wheat. They are rich in mineral salts, particularly iron and calcium and contain a fair amount of vitamins A (carotene) and B with a trace of vitamin C. The date tree flourishes in the desert, and the dates are the staple food of the people in the African and Arabian deserts.

Figs :—Figs contain a fair percentage of carbohydrate mostly in the form of sugar. They contain valuable mineral salts, and are a good source of carotene with a trace of vitamin C. The fig has a laxative property, and is most effective when two or three figs are steeped overnight in a quantity of water that it can absorb, and eaten in the morning. The figs should not be taken in large numbers, as they are apt to cause irritation of the bowels.

Tamarind :—It contains all the fruit acids, *viz.*, citric, tartaric and malic. It possesses a nutritive value, inasmuch as it contains a fair percentage of carbohydrate in the form of invert sugar, and also vitamins B and C in small amounts together with mineral salts. It is laxative in its action. It possesses the property of diminishing thirst and producing a cooling effect on the system. As we know, some of the vitamins are very sensitive to heat, and tamarind with its high acidity is believed to possess the property of preserving these vitamins. Therefore, the addition of a little tamarind juice to cooking water increases the value of food.

Nuts

Percentage Composition :—

	Water	Protein	Fat	Carbohydrate	Minerals
Almonds ...	5·2	20·8	58·0	10·5	2·9
Walnuts ...	4·5	15·6	64·5	11·0	1·8
Groundnuts ...	7·9	26·7	40·1	20·3	1·9
Cocoanuts ...	36·3	4·5	41·6	13·0	1·0

Nuts are exceptionally rich in fat, and also fairly rich in protein with a comparatively low carbohydrate content. They are all rich in vitamin B_1, and contain a moderate amount of vitamin A (carotene) with little or no vitamin C. They are a good source of important mineral salts. Though the proteins of nuts are not as good as those of meat, fish, etc., they are considered to be better than those of cereals and pulses. In one sense, however, the nut proteins are superior to the animal proteins, inasmuch as they do not appear to produce much toxic waste. Due to the existence of a very high percentage of fat, the nuts are the most energy-bearing food. Besides, their protein contents exceeding even those of meat and fish, place them among the rich body-building foods. In short, they contain all the principal elements of nutrition, but in a highly concentrated form. Though very nutritious, they are rather difficult to digest. When finely ground or thoroughly masticated, they admit of easier digestion, and form a wholesome part of meals. The best way of eating nuts is to grind them and then cook them with confection. Cooking softens their fibres, and makes them easier to digest. In any case, the nuts should be taken in moderation, and must not be eaten as a mono-diet. The high percentages of fats and proteins, and also their hard fibres are bound to cause intestinal disturbances, if eaten to excess.

Almonds :—Almonds are particularly rich in iron, calcium, phosphorus and potassium. They contain a fair amount of vitamin B, with a trace of carotene. They are hard to digest and should be thoroughly masticated. The ordinary almond oil extracted from sweet almonds, is bland and harmless. But the oil extracted from bitter almonds is said to contain hydrocyanic acid which is dangerously poisonous. The acid may be driven off by heat, and when so done the oil is harmless.

Walnuts :—Walnuts are superior to almonds, inasmuch as they are more easily digestible, and richer in vitamin B and also

carotene. They are a good source of minerals, particularly iron. They may be taken in combination with almost anything, such as cereals, fruits etc.

Cocoanuts :—Every part of the cocoanut and its tree is useful. The flesh of the mature cocoanut containing a high percentage of fat and also hard fibres, is very difficult to digest, but it contains a ferment which aids the digestion of the proteins of meat. This ferment is more effective when the cocoanut is young. The fruit contains a small amount of vitamin B, with a slight trace of vitamin C. The cocoanut oil holds a small amount of fatty acid which causes intestinal fermentation. It should, therefore, be used in cooking with some reservaion. The fluid of a green cocoanut contains a fair amount of valuable sugar with traces of nitrogen and fat. It also contains traces of vitamins A (carotene) and B_1 along with mineral salts. It is a pleasant and refreshing drink.

Groundnuts :—Groundnuts are the cheapest of all kinds of nuts, but they are very difficult to digest. They are, however, a good supplement to the diets of the poor when taken in moderate quantity. They contain a fair amount of vitamin B_1 together with a small amount of carotene. Groundnuts cooked with Gur (Jaggery) and made into a sweetmeat, are easier to digest, but in no circumstances, groundnuts should be taken habitually in excess, as they are apt to upset the liver, and for the matter of that, the whole digestive system.

Preserved Foods

The history of the preservation of food can be traced back to remote ages. Freezing and drying had been in vogue among our ancestors for preventing the decomposition of foodstuffs. But their methods were more or less crude, resulting in the loss of some vital food elements. The crux of the whole problem is how to maintain the values of food intact, while adding to its keeping

property. Recent development in the methods of preservation has brought many new lights to us, and the future of the preserved foods is full of possibilities. It should be remembered that it is the "protective" elements of food, *i.e.*, vitamins and minerals which are most affected by faulty "processing". This explains why the ancient sailors on long non-stop voyages depending mainly on preserved foods, were often the victims of such "deficiency" diseases as Scurvy, Beri-beri, etc. Modern processing of food has eliminated this risk to a considerable extent, and will bring some relief to the distressed world which is crying for more an more food. Food of perishable nature can now be transported from the surplus to the deficient area regardless of distance, and the surplus food in any particular season can be properly preserved without much risk of deterioration, to tide over a lean season. The food industry, however, is still in its infancy, working within a very limited sphere, but it holds out promise of an all-round expansion in the near future, with far-reaching effects on the whole food economy.

One of the popular methods by which food is processed is known as Refrigeration. Cold, as we know, prevents decomposition, while warmth and moisture encourage it. Now that decomposition is the result of the activities of germs from air, cold necessarily affects the germs somehow or other. This does not, however, mean that cold altogether destroys the germs. What it does is to make them inert, and as soon as the temperature returns to normal, the germs become active. Boiling kills the germs, and hence it is necessary to boil such refrigerated foods as meat, fish, and dairy products, before eating. Air being the source of germs, it is important to exclude it in the processing of those foods which are to be taken without boiling.

There is another important method of preserving food, and that is by drying or what is technically called "Dehydration".

The primitive method of drying was to expose the foodstuffs to the sun for days together. According to modern process, dehydration is done mainly by passing a current of hot air through them, the degree of heat employed and other details of the operation varying according to the nature of foodstuffs. Many vegetables, particularly potatoes, are dried by this process with their food values well maintained, though there is risk of loss of a considerable amount of vitamin after a few months' storage. Even cooked foods like vegetables and meat are dehydrated now a days. They are dried in a mass which is cut into small pieces preparatory to packing in tins. The only thing for the consumer to do is to immerse the content in boiling water for 3 or 4 minutes, when it is ready to eat. Though these foods prove invaluable in times of emergency, they should not be habitually taken, because they are very liable to lose their vitamin and mineral contents as the result of a series of manipulations to which they are subjected.

Milk powder, condensed milk, and many popular "infant foods" like Allenbury's, Horlick's etc. are familiar examples of dehydration in the milk industry. Modern forms of dehydration have opened up opportunities for the development of the fruit industry on a much wider scale. Besides drying up the whole fruit, it is just possible to preserve even fruit juices in a dehydrated form. According to considered opinion, it is not out of bounds to produce powdered lemon juice, powdered mango juice etc., just like powdered milk, without very much affecting their food values.

To these may be added the way of preserving foods by what is popularly known as canning *i.e.* packing in tins. The canning industry has made rapid progress in the past few years, bringing within its range a variety of foodstuffs, such as fruits, vegetables, meat and fish. These foods are widely used today, particularly the tinned fruits—whole or in other forms, such as jellies, jams,

squashes etc., and it is found that with proper precaution the food values are very well maintained. Many canned fruits are considered to retain even their original vitamin values almost intact, such as tomatoes, oranges, grape-fruit, strawberries, gooseberries, raspberries etc. Further scientific researches are, however, necessary to standardise them and make the consumption of such foods safe fom all points of view.

ANIMAL FOODS *VS.* VEGETABLE FOODS

Having regard to the scope of our study, we need hardly enter into any discussion of academic nature regarding the long-standing controversy between the vegetarians and the non-vegetarians. Leaving aside the moral issue involved in the matter, it can be said that most of the arguments advanced by the exponents of the two schools of thought in support of their respective cases have hardly any significance to-day on the face of the discoveries made by the modern Nutritional Science.

Now to make a proper estimate of the merits and demerits of animal and vegetable foods from the nutritive point of view, first of all it is necessary to bear in mind that in practice there hardly exists any sharp line of demarcation between these two foods. Both the foods are so mixed up that it is often difficult to say which is which. In fact, the vegetarian has as wide a range of choice in the matter of foods as his vis-a-vis. To illustrate the point, let us take a concrete example. Milk, as we know, falls in the category of animal foods. Yet the vegetarian does not consider this foodstuff as a "taboo" in his dietary. Rather he advocates more and more liberal consumption of milk and its products. It may, therefore, be said that there are practically none among the vegetarians who insist on a diet exclusively drawn from the plant kingdom, except a very limited few who may well be dubbed "faddists". Many of them even go so far as to include eggs in the category of vegetable

foods. Thus the main point of controversy between the vegetarian and his opponent now boils down to the question of eating meat and fish, particularly meat.

As we remember, meat and fish occupy a subordinate position in the list of "protective" foods. Milk and its products including butter are given the place of honour, and then come in order eggs, green leafy vegetables and fresh fruits, and last of all meat and fish. We also remember that meat and fish are rich in "good" proteins which admit of easy assimilation, but are poor in minerals and vitamins. Many of the green vegetables along with cereals also contain proteins, but in small amounts. On the other hand, the vegetables along with fruits are the richest sources of minerals and vitamins. Here a very important question arises—how should the vegetarian make up the protein deficiency in his food? Pulses, peas, and beans commonly called legumes, undoubtedly contain as much proteins as meat and fish, but their proteins are "poor" in comparison with those of meat and fish, inasmuch as their assimilation involves a greater amount of strain on the digestive system, and also greater wastage. In other words, the proteins of meat and fish are biologically superior to those of legumes. The vegetarians here are cetainly at some disadvantage in comparison with flesh eaters. But it may be pointed out that an addition of milk and its products in the diet of the vegetarian acts as a corrective measure, inasmuch as the "good" protein of milk while giving the most efficient form of nutrition by itself, increases the biological values of the proteins of legumes, cereals and other vegetables in the diet. But here we want to remember that milk is a very rare and costly commodity, and it is not practicable for each one of us to obtain it in a quantity sufficient for the purpose of nutrition. Apart from the question of protein, there is another important factor which has to be borne in mind, and that is the factor of climate. Meat, as we know, is a very heat-producing

food, and as such, it admirably suits the people in the cold regions. In fact, there is hardly any substitute for meat in the menus of the people living in an extremely cold region, such as the Arctic. Having regard to all these practical considerations, it can be said that meat and fish can not be altogether discarded by mankind, whatever the vegetarians may say to the contrary. At the same time, it should be remembered that in a warm climate, meat should be taken sparingly in order to avoid unnecessary stimulation and heat in the body.

While there are practical difficulties standing in the way of the universal adoption of a well-balanced vegetable diet, it is interesting to point out that such a diet is considered by many rational thinkers to possess some virtues of its own. It is claimed that a vegetable diet gives more power of endurance than a meat diet. The protein of meat, as we may remember, has something like a "dynamic action" acclerating oxidation process in the body, and thus producing heat and energy at a quick pace. This may have some bearing on the activity of a meat-eater who seems to be very lively and efficient in a short-term work, but when engaged in a long-term work demanding sustained energy, he often becomes more easily spent up than the vegetarian. It is also widely believed that a vegetable diet tends to add to longevity, sustain the prime of life, and ward off the senility of old age, while meat by hardening the arteries more quickly than any other food, tends to make a man prematurely old with all its evil consequences. However controversial this view may be, there are instances furnished by lives of many remarkable men who have lived to a good old age on a vegetarian diet, with their faculties very well maintained.

We have discussed all the salient points regarding the merits and demerits of animal and vegetable foods, and taking all the relevant facts into consideration strictly from the nutritive point

of view, we may say that the meat-eaters and the vegetarians can obtain equally good nourishment from their foods, provided that they prepare their diets with discretion. Leaving aside the question of such energy-yielding foods like rice, wheat etc. which form part of both the diets, the points which demand special attention, are that while a vegetarian should supplement his food with milk and its products for efficient utilisation of vegetable proteins, the flesh-eaters should add to his diet fair quantities of vegetables and fruits to make up the deficiency of minerals and vitamins, so essential to maintenance of health. Such a course will put both of them almost on a par in the matter of nutrition. It is now only a matter of choice, taste and pre-disposition whether a normal man should be a vegetarian or a non-vegetarian.

Now that both the animal and the vegetable foods are considered by the science of nutrition to be equally nutritious in normal circumstances, there is no longer any ground for serious controversy between the two schools, though the ethical aspect of the question will continue to exercise the mind of thinkers in all ages.

CHAPTER XX

CONDIMENTS & COOKING

Condiments

Broadly speaking, the condiments include not only spices but also common salts, and other flavouring substances. Common salt, however, stands on a different footing from spices and aromatics in view of its indispensibility to the nutritive processes of the body. We are, therefore, concerned here only with those

condiments which, though more or less rich in all the elements of food including minerals and vitamins, are at best only aids to digestion. They may be considered more or less luxuries of the table, which do more injury than good when taken too freely. They are undoubtedly great appetisers as well as stimulants, and in many cases, antiseptic, retarding the process of fermentation. Spices accelerate digestion mainly by causing irritation in the stomach as the result of which there is increased flow of blood and necessarily increased secretion of the gastric juice. The irritation ultimately produces catarrah on the mucous membrane of the stomach, which slowly but surely becomes impaired, with the result that it fails to give response to the natural diets without the aid of a stimulant. In a healthy stomach the intake of food is enough to stimulate the secretion of the gastric juice, but when one becomes accustomed to sharp condiments, the stomach becomes merely a slave. It is, therefore, prudent to practise moderation in uses of stimulating condiments, however necessary they may be to relieve the monotony of food. In cases of weak digestion and small appetite, the milder type of stimulants is often useful not as an end but as a means to restore the natural tone of the stomach. It cannot be denied that taste is a thing which is more or less cultivated, and the plain and simple food proves quite palatable to a person once the habit is formed. Therefore, high spices have no place in the dietaries, but those of non-irritating character with only flavouring qualities, are often useful.

The condiments may be classified as follows :—

(1) Acids— Vinegars, lemon juices, tamarind etc.
(2) Pungents— Chillies, pepper, mustard, ginger, etc.
(3) Aromatics—Cardamom, Cinnamon, cloves, turmeric, aniseeds, corriander-seeds, nutmeg, onion, garlic, etc.

(1) Acids

Vinegar :—The acid of vinegar is known as Acetic acid. It is formed in the course of fermentation of alcohol, caused by the activity of some micro-organism. Vinegar is generally used in the preparation of sauces, which are used as a dressing to give taste to foods. It has the property of allaying thirst and checking perspiration. It is sometime used with partial success as a remedy for obesity, but such a remedy often proves more harmful than the disease itself. It diminishes fat only by producing catarrah on the stomach, thus ultimately interfering with the nutrition of the body. It is, therefore, harmful to make a habit of taking vinegar regluarly.

Lemon & Lime Juice :—The citric acid contained in the juice is beneficial, inasmuch as it helps in maintaining the acid-base balance of the blood. The juice contains plenty of vitamins and mineral salts and is a sure protection against Scurvy. All sorts of food, particularly vegetables, may be seasoned with the juice to make them palatable. A drink containing the juice, is an exceedingly refreshing beverage.

Tamarind Juice :—It contains all the fruit acids, and possesses some food-values. It is cooling and refreshing, allaying thirst. It preserves vitamin C to some extent when added to vegetables in cooking.

(2) Pungents

Most of the pungents more or less contain essential oils which account for their peculiar aromas and medicinal properties.

Chillies :—Green chillies are fairly rich in vitamin C with a trace of carotene. They are irritating, and should not be taken too freely. Excessive intake of green as well as red chillies is considered to be one of the causes of gastric ulcer.

Black Pepper (*Gol Marich*) :—It is stimulating to the digestive organs and also carminative. It contains an essential oil to which it owes its medicinal values. Though an appetiser, it is irritating, and hence it should not be taken too freely. It is particularly rich in iron and calcium.

Long Pepper (*Pipul*) :—It is more powerful as a stimulant than Black pepper, and contains an essential oil. It relieves cough and hoarseness. It can be called a store-house of iron, and very few substances can stand comparison with it in this respect. It is also rich in calcium.

Mustard :—Regular intake of mustard produces blisters in the stomach, and hence it should not be taken too frequently as a means of stimulating the flow of gastric juice. It is a rich source of iron, phosphorus and calcium.

Ginger :—It is carminative and stomachic. Besides its stimulating effect on the flow of gastric juice, it has got medicinal properties due to the presence of a volatile oil.

(3) Aromatics

Cardamom (*Elachi*) :—The essential oil contained in it, gives it a powerful aroma. It is stimulant, and relieves flatulence.

Cinnamon (*Darchini*) :—The aroma as usual is due to the presence of an essential oil. It is astringent and antiseptic.

Cloves (*Labanga*) :—The clove is rich in the essential oil. It is stimulant, antiseptic, and germicidal. It is particularly rich in calcium.

Turmeric (*Halud*) :—The essential oil contained in it is small in quantity It is astringent, antiseptic and preservative. It has a tendency to retard digestion to some extent. It is particularly rich in iron.

Bay-Leaf (*Tejpata*) :—It is non-irritant and soothing.

Corriander (*Dhanya*) :—It is carminative and stomachic. It is very rich in carotene, iron and calcium.

Aniseed (*Mouri*) :—It is not only carminative but also sedative, relieving griping pain.

Asafœtida (*Hing*) :—It is stomachic, and aids digestion. It is very rich in iron and also calcium.

Cumin (*Jira*) :—It is carminative and stomachic, and cooling in effect. It is exceptionally rich in iron and calcium. It is a very good source of carotene.

Nutmeg (*Jaitri*) :—The nutmeg is very rich in an essential oil giving a strong aromatic taste. It is carminative and stimulating. It is particularly rich in fat and is considered to be narcotic when taken in large doses.

Cooking

Cooking occupies an important place in the science of nutrition. Foodstuffs, however nutritious they may be, cannot give us their full values unless proper care is taken about the way in which they are cooked. Majority of the housewives lack knowledge of the most elementary principles of preparing foods with the result that there is unnecessary wastage of food elements. In a poor country like India where most of the people are under-nourished, the question of cooking is all the more important. In order to grasp the basic principles of the subject, we must first of all be familiar with the object of cooking. It must be remembered that our digestive apparatus is different from that of animals. The animals may take their foods in a raw state and obtain the necessary nourishment. But men have got a finer digestive apparatus which demands that most of the raw foodstuffs must undergo some preparations before they can be utilised by the body. They must be made tender and soft to suit our digestive apparatus, and here

we see the main object of cooking. Moreover, with the progress of civilisation men have developed certain tastes, and we know how the satisfaction of palate is a condition precedent to proper digestion. If the foods are repugnant to taste, monotonous, and without flavour, there can not be proper flow of digestive juices with the result that we cannot make the best use of all the nutrients. Then it must be remembered that boiling kills bacteria and naturally it minimises the possibility of our contracting infection. All these facts suggest the necessity of cooking before we eat our foods.

In preparing the foodstuffs, we must first of all see that the maximum food values are maintained during the process of cooking consistent with tenderness and taste. As a general rule, the degree of tenderness just desired for a foodstuff must not be over-reached, as unnecessary boiling is bound to cause the loss of some essential food elements. It is the vitamins and mineral salts that are most affected by boiling, and particular care should be taken in cooking what are called "protective foods", *e.g.*, milk, green vegetables etc.

Besides unnecessary boiling, there are certain other injudicious practices prevalent among us, which also affect the nutrients of foods. We often add baking soda to foods to hasten boiling. This not only destroys vitamins but also mineral salts to a considerable extent. It is a habit of many of us to allow foods to get cold before eating. This affects digestion, as for proper digestion the foods must be taken at body temperature. Moreover, cold foods encourage the growth of bacteria, and particular attention should be given to this point during epidemics. Frequent heating of foods is also undesirable, as every time they are boiled, there is loss of some vitamin content. There is a practice of excessive washing of rice and throwing out the watery portion at the final stage of cooking. This, it must be remembered, causes the loss of a considerable amount of vitamin and mineral contents.

In preparing the vegetables, we are in the habit of paring them very thickly, forgetting that much of their nutrients, particularly vitamins and minerals, lies close to the skin. Cooking of foods in open utensils is another bad practice. This causes contact of the foods with air, and consequent loss of vitamins by oxidation. The use of closed cookers eliminates the possibility of such waste to a great extent.

In the light of the knowledge gained by the foregoing discussion, we may now examine the proper methods of cooking of some of our representative foodstuffs.

Milk

Excessive boiling of milk causes the loss of vitamins, particularly vitamin C and also calcium. On the other hand, there is a distinct danger of taking milk unboiled, owing to micro-organisms growing in it. It is thus a problem how to preserve the full values of milk in the process of boiling, which is so essential to make it free from contamination by bacteria. The modern process of pasteurisation of milk is a solution of the problem to a great extent. By this process the milk is kept on the fire at a low heat for a fairly long time, say about half an hour. This cuts both ways, serving the purpose of sterilisation, as well as preserving the vitamin content and calcium.

Cereals and Vegetables

Grains and vegetables require prolonged boiling to make them tender. They contain fibres and cellulose which must be ruptured in order to make them fit for consumption. The cereals, such as rice, barley etc. being dry, have to be boiled in a larger quantity of water than the vegetables. Green vegetables specially of leafy kinds are rich in vitamins and minerals. Hard boiling is bound

to cause the loss of these important elements to a considerable extent, and proper care should be taken to boil them in covered utensils just to obtain the desired tenderness and no more. The mineral salts and vitamins are liable to be removed by water, and hence the vegetables, particularly the leafy ones, should be boiled in as little water as possible. It is believed by some dietic experts that boiling in hard water causes some saving of mineral salts. An addition of a small quantity of salt to the water previous to boiling will serve the purpose.

Animal Foods :—The most important nutrient of animal foods is protein. It is more or less soluble in cold water, and in that condition it is readily digested. This particular feature of proteins of animal foods does not seem to encourage their boiling. But boiling cannot be ruled out in any case, as the foods must be made tender to suit the human organism. Unnecessary boiling coagulates the protein, making it insoluble and hard for digestion. It also causes a considerable loss of extractives of meat, which give it so much flavour and taste. All these facts suggest that, as a general rule, the animal foods should be moderately boiled just to make them tender for consumption. The proper method of boiling is to apply the heat gradually. This will avoid the unnecessary waste of protein and extractives while rendering the foods tender and soft. The more thoroughly they are cooked the longer is the time required for digestion. Regarding meat, it is necessary that, as far as possible, its juice should be preserved within it. For this purpose the meat at the first instance may be treated with boiling water for a few minutes and subsequently the cooking may be continued at a low heat. This will cause a very moderate coagulation of the protein, preventing the exudation of the juice. The animal foods should also be cooked in closed utensils for reasons already noted.

Frying

Frying gives excellent taste to many articles of food, though fried foods are less easily digestible than the boiled ones. Frying is the most abused method of cooking due to the ignorance of the housewives, with the result that fried foods do more harm than good. Many of us use shallow pans forgetting that frying must be done in deep fat not only to make an article more easily digestible but also more tasty. It should be remembered that fat is the vehicle of communicating heat to the article in the process of frying, just as water is in the case of boiling. So for the proper and uniform cooking of the interior of the article it should be immersed in deep oil. Fat boils at a much higher temperature than water, and hence when fat is introduced into the pan the watery portion at first evaporates. Then the fat becomes calm and motionless, and at this stage a piece of meat or fish may be introduced. The protein of the article at once coagulates preventing the exudation of the juice from its interior, and it is then uniformly cooked by its own juice. When this method is adopted the fried article is juicy, tender, delicate to the taste, and easy to digest. But when it is fried in a flat pan adding fat in driblets, the interior remains more or less unbaked while the exterior becomes stiff and shrivelled, difficult to digest, because the digestive juices cannot easily penetrate into it.

CHAPTER XXI

DRINKS

Alcohol

Of all the intoxicants, alcohol occupies a peculiar position. No intoxicant is so much praised and also so much condemned in the same breath. When the habit is first formed, everything looks rosy and life becomes a paradise of joy. But ultimately when the evil effects are manifested in all their horrors, life becomes a veritable hell with body and mind hopelessly shattered. Alcohol can neither be called food nor tonic in its proper sense. It at first acts as a stimulant but soon afterwards as a depressant. When taken in moderate doses, it may produce marvellous results under certain conditions of health, even averting a dangerous crisis, but once the habit is formed it will slowly but surely undermine the constitution.

Having regard to the scope of our present study, we are first of all concerned with the question whether alcohol has any nutritive value. The component parts of alcohol being carbon, hydrogen and oxygen, it naturally furnishes some energy of heat as the result of combustion. But the heat is very short-lived, as alcohol dilates the blood-vessels under the skin, causing perspiration and consequent loss of heat. Also a certain portion of the substance passes off quickly by breath, urine and skin, quite unchanged. It irritates the mucous membrane of the stomach causing copious flow of blood to that region, and for the matter of that, a larger flow of gastric juice than usual. It, therefore, aids digestion to a certain extent, but only when taken in small doses at meals. It may be taken with benefit by those who are suffering from weak digestion, but its prolonged use is bound to prove harmful. When taken in heavy doses, it rather retards digestion, as any excessive

secretion of the gastric juice causes acidity and ultimately indigestion. Moreover, over-stimulation often paralyses the membrane of the stomach causing the arrest of the flow of the digestive ferment.

Alcohol has a special affinity for the hæmoglobin of the blood. By its paralytic effects it makes the blood corpuscles momentarily incapable of carrying oxygen from the lungs to the tissues, as a result of which the normal metabolism of the body is very much hampered. With diminished oxidation there is less tissue waste, and the result is the fibrous degeneration of the various organs, which usually lose their delicacies, and become thickened. The stomach, the kidneys and particularly the liver become hardened, and their functions become imperfect with all its dangerous consequences. The diminution of tissue waste may sometime prove beneficial in a state of disease, but in a state of health it is not at all desirable that the old tissues should be allowed to remain for any length of time without renovation.

All these facts point to the conclusion that although the caloric value of alcohol is as high as fat, it has hardly any nutritive value in the long run.

In view of its stimulating property, alcohol naturally has effects on the heart, the circulation of blood, and also the nervous system. In small doses, it quickens the activity of the heart and also the flow of blood. The stomach, the liver, the spleen and the kidneys are engorged with blood and the normal circulation is completely upset. The blood-vessels become dilated and hence the flush that is seen in the face. The nervous system is also stimulated, and with the increased flow of blood the brain becomes very active with an irresistible current of thoughts and ideas, and quickening of intelligence. In large doses, it causes an irregular beating of the heart and sometime even its complete stoppage. The whole nervous system is paralysed, and the effect is more

markedly felt in the brain and also in other vital nerve centres. The brain centre is overpowered and senses are clouded. Loss of self-control, unsteady gait, incoherent and rambling speeches—all testify to the narcotic effects of the free use of alcohol. The permanent redness of the face, nose, etc. of the veteran drunkard is due to the partial paralysis of the nerves.

It does not fall within the scope of this book to discuss the effects of alcohol from the moral and social points of view, but the effects are so far-reaching and so disintegrating that a brief reference to them may be pardonable. As has been seen, the brain centre is seriously affected by alcoholic drink, and the ultimate result is that the rational part of a man's nature gives way to animal instincts. A man loses his sense of decorum and self-respect, and sinks into the lowest depth of degradation. He lets loose all his immoral propensities and perpetrates the darkest crimes without the least pricking of conscience. The man is doomed for ever without any hope of redemption.

Alcohol also breaks up social bonds, so much so that even the parental instincts are lost. The children often pay for the misdeeds of their parents. They are apt to inherit not only their immoral propensities but also their physical infirmities. Thus the habit of drinking is a distinct menace to the society.

Tea

Tea is the most democratic drink widely consumed in all climes by the rich and the poor alike. The growth of its consumption has been rapid in recent times, specially among the poorer classes.

It contains an active principle known as Thein (caffein) and an astringent substance named Tanin. It also possesses an aromatic oil which gives flavour to the drink. This oil does not exist in tea when fresh, but is produced in the drying process.

Thein has a stimulating property, and when taken moderately, tea quickens the heart-beats and also the respiratory and muscular movements. It also produces an action on the nerves and quickens thought to some extent. It increases the activity of the skin and also of the kidneys. Excessive tea has a tendency to produce narcotic effects, causing nervous excitement, trembling of hands and arms. The aromatic oil may even cause paralysis to which the packers of tea are specially liable. Tanin has an astringent property and it leads to constipation. The longer the infusion is, the higher is the proportion of Tanin dissolved. Strong tea habitually taken, hardens the mucous membrane of the stomach, precipitates the gastric juice, thus hindering digestion

In view of what has been said above, tea cannot be considered as a nutrient. It is only a pleasant beverage without much harmful reaction, if taken moderately. Tea causes increased exit of carbonic acid gas by the lungs and this leads to the assumption that there is increased combustion of fats and carbohydrates in the body. As has been said above, tea accelerates the movement of the heart and respiration, and also increases the loss of heat from the body by encouraging perspiration. The energy thus lost must be replaced by an increased amount of food. Tea is, therefore, not a very desirable drink for those who are starving or fasting. It is usually suitable for those who have plenty to eat. Excessive tea kills appetite in view of its effects on the mucous membrane of the stomach and the digestive juice. This is one of the causes why tea is so popular among those who are in extreme poverty. Tea is considered to retard digestion of starch to some extent.

Coffee

It is also only a stimulating beverage like tea, and its active principle is Caffein which is the same as the Thein of tea. It has

also an aromatic oil and Tanin, but all these, *i.e.*, Caffein, Tanin and aromatic oil, are not so conspicuous as in tea. For this reason coffee can be taken a little more freely than tea. It produces stimulating effects upon the nerves, the heart, and also the respiration, but not to the same extent as tea. It also increases the exit of carbonic acid gas through the lungs like tea, and acts upon the kidneys increasing the quantity of urine. The active principle, *i.e.*, Caffein, is a remedy for nervous headache. Coffee is also said to retard digestion of starch, but in a less degree than tea.

Cocoa

It is not only a pleasant drink but also a nutritious food. Its active principle is Cocaine, but it possesses very little aromatic oil and practically no Tanin. It contains a large quantity of fat which along with its proteinous and starchy constituents gives it a distinct food value. The drink is not an infusion but only a mixture with hot water. It is for this reason that all the food elements are directly introduced into the body, while in the infusion of tea and coffee these substances are lost. Its fat content is fairly large, and the saline matters consist of potash and phosphates. Its active principle, the Cocaine, kills the sensation of skin and mucous membrane. It can, therefore, be used in minor operations without causing any pain.

APPENDIX I

*TABLES OF COMPOSITION OF FOODSTUFFS.

(Percentage of fibres present not shown.)

MILK AND ITS PRODUCTS.

Name of Foodstuff.	Water.	Protein.	Fat.	Carbo-hydrate.	Mi-neral.	Calories per 100 gms.
Milk Ass	91.0	1.7	1.0	6.5	0.4	47
Milk Cows ...	87.6	3.3	3.6	4.8	0.7	65
Milk Buffalo's ...	81.0	4.3	8.8	5.1	0.8	117
Milk Goat's ...	85.2	3.7	5.6	4.7	0.8	84
Milk Human ...	88.0	1.0	3.9	7.0	0.1	67
Curd (Dadhi) ...	90.3	2.9	2.9	3.3	0.6	51
Butter	12.0	1.5	85.0	....	1.5	790
Butter Milk ...	97.5	0.8	1.1	0.5	0.1	15
Skimmed Milk ...	92.1	2.5	0.1	4.6	0.7	29
Skimmed milk Powder	4.1	38.0	0.1	51.0	6.8	357
Cheese	40.3	24.1	25.1	6.3	4.2	348
Cream	70.0	2.5	24.0	3.5	1.75	245
Casein (Chhanna) ...	57.5	21.5	17.5	0.75	1.75	252
Sandesh	20.0	19.5	20.2	40.0	1.50	330

FLESH FOOD.

Name of Foodstuff.	Water.	Protein.	Fat.	Carbo-hydrate.	Mi-neral.	Calories per 100 gms.
Beef (Muscle) ...	74.3	22.6	2.6	....	1.0	114
Crab (muscle) ...	83.5	8.9	1.1	3.4	3.2	60
Eggs (Duck) ...	71.0	13.5	13.7	0.7	1.0	180
Eggs (Fowl) ...	73.7	13.3	13.3	....	1.0	174
Fish (Rohit) ...	72	18.35	7.55	....	1.40	140
,, (Vetki) ..	75	16.25	4.10	....	0.85	105
,, (Hilsha) ...	75	14.85	9.20	....	0.95	150
,, (Mango) ...	80	16.75	4.10	....	0.85	109
,, (Magoor) ...	78	19.50	0.50	....	1.30	85
,, (Kai) ...	80	17.75	0.45	....	1.00	78
,, (Tangra) ...	82	17.30	0.30	....	1.10	72
,, (Parshe) ...	77	15.75	6.2	....	1.0	120

*Most of the figures are taken from Bulletin No. 23 published by the Government of India.

Name of Foodstuff.	Water.	Protein.	Fat	Carbohydrate.	Mineral.	Calories per 100 gms.
Fish (Mangalore, big)	78.4	22.6	0.6	....	0.8	90
,, (Mangalore, small)	77.9	21.5	1.6	....	2.0	100
Chicken ...	74.0	21.0	3.0	....	1.0	114
Liver (Sheep) ...	70.4	19.3	7.5	1.4	1.5	150
Mutton (Muscle) ...	71.5	18.5	13.3	....	1.3	195
Mutton (Lean) ...	74.0	17.0	3.0	....	4.0	100
Mutton (Fat) ...	56.0	11.0	28.0	....	3.0	300
Prawn (Muscle) ...	77.9	20.8	0.3	....	1.4	85

CEREALS.

Bajra or cambu ...	12.4	11.6	5.0	67.1	2.7	360
Barley	12.5	11.5	1.2	69.3	1.5	335
Cholam	11.9	10.4	1.9	74.0	1.8	355
Maize, tender ...	79.4	4.3	0.5	15.1	0.7	82
Maize, dry ...	14.9	11.1	3.6	66.2	1.5	342
Maize, Flour ...	11.5	0.6	0.5	87.0	0.4	355
Oatmeal	10.7	13.6	7.6	62.8	1.8	374
Ragi	13.1	7.1	1.3	76.3	2.2	345
Rice, raw, home-pounded	12.2	8.5	0.6	78.0	0.7	351
Rice, par-boiled, home-pounded ...	12.6	8.5	0.6	77.4	0.9	349
Rice, raw, milled ...	13.0	6.9	0.4	79.2	0.5	348
Rice, par-boiled, milled	13.3	6.4	0.4	79.1	0.8	346
Rice, flakes ...	12.2	6.6	1.2	78.2	1.8	350
Rice, beaten (Chira)	12.5	7.8	0.01	77.5	3.2	344
Rice puffed (Muri) ...	14.7	7.5	0.1	74.2	3.4	328
Samai	11.5	7.7	4.7	63.7	4.8	328
Fried paddy (Khai) ...	14.0	7.2	0.2	77.0	1.8	342
Sati flour (Palo) ...	15.0	3.4	3.5	75.0	....	360
Wheat, whole ...	12.8	11.8	1.5	71.2	1.5	340
Wheat, flour, whole (atta)	12.2	12.1	1.7	72.2	1.8	353
Wheat, flour, refined ...	13.3	11.0	0.9	74.1	0.4	349
Bread	40.0	8.8	1.5	50.0	1.3	248
Boiled rice (Bhat) ...	50.0	4.8	0.8	45.0	0.4	215
Biscuit	8.0	15.5	1.3	73.5	1.6	370
Chapati (Atta Ruti) ...	17.0	10.0	1.6	68.0	1.7	330
Loochi	20.0	7.0	22.5	50.0	0.5	440

LEGUMES (Pulses).

Name of Foodstuff.	Water.	Protein.	Fat.	Carbo-hydrate.	Mi-neral.	Calories per 100 gms.
Bengal gram (with outer husk) ...	9.8	17.1	5.3	61.2	2.7	361
Bengal Gram, roasted (without outer husk)	11.2	22.5	5.2	58.9	2.2	372
Black Gram (without outer husk) ...	10.9	24.0	1.4	60.3	3.4	350
Cow Gram ...	12.0	24.6	0.7	55.7	3.2	327
Field Bean, dry ...	9.6	24.9	0.8	60.1	3.2	347
Green Gram (with outer husk)	10.4	24.0	1.3	56.6	3.6	334
Horse Gram ...	11.8	22.0	0.5	57.3	3.1	322
"Khesari"	10.0	28.2	0.6	58.2	3.0	351
Lentil (Masur dal) ...	12.4	25.1	0.7	59.7	2.1	346
Peas, dried ...	16.0	19.7	1.1	56.6	2.1	315
Peas, roasted ...	9.9	22.9	1.4	63.5	2.3	358
Red Gram (Dal arhar) (without outer husk)	15.2	22.3	1.7	57.2	3.6	333
Soya bean ...	8.1	43.2	19.5	20.9	4.6	432

LEAFY VEGETABLES.

Name of Foodstuff.	Water.	Protein.	Fat.	Carbo-hydrate.	Mi-neral.	Calories per 100 gms.
Amaranth, tender ...	85.8	4.9	0.5	5.7	3.1	47
Amaranth, spined ...	85.0	3.0	0.3	8.1	3.6	47
Bamboo, tender shoots	87.1	3.9	0.5	7.5	1.4	47
"Bathua" Leaves ...	87.9	4.7	0.4	3.7	3.3	37
Bengal Gram leaves ...	77.8	7.0	1.4	11.7	2.1	87
Brussels sprouts	84.6	4.7	0.5	9.2	1.0	60
Cabbage ...	90.2	1.8	0.1	6.3	0.6	33
Carrot leaves	83.3	5.1	0.5	8.3	2.8	58
Celery ...	81.3	6.0	0.6	8.6	2.1	64
Coriander ...	87.9	3.3	0.6	6.5	1.7	45
Curry leaves	66.3	6.1	1.0	16.0	4.2	97
Drumstick	75.0	6.7	1.7	13.4	2.3	96
Fenugreek	81.8	4.9	0.9	9.8	1.6	67
Garden Cress	82.3	5.8	1.0	8.7	2.2	67
Gram leaves	60.6	8.2	0.5	27.2	3.5	146
Ipomoea ...	90.3	2.9	0.4	4.3	2.1	32
Khesari leaves	84.2	6.1	1.0	7.6	1.1	64
Lettuce ...	92.9	2.1	0.3	3.0	1.2	23

Name of Foodstuff.	Water.	Protein.	Fat.	Carbo-hydrate.	Mi-neral.	Calories per 100 gms.
Mint	83.0	4.8	0.6	8.0	1.6	57
Neem, mature ...	59.4	7.1	1.0	22.9	3.4	129
Neem, tender ...	59.4	1.6	3.0	21.2	2.6	158
Parsley	68.4	5.9	1.0	19.7	3.2	111
Rape leaves ...	84.9	5.1	0.4	7.1	2.5	52
Safflower leaves ...	89.9	3.3	0.7	5.1	1.0	40
Spinach	91.7	1.9	0.9	4.0	1.5	32
Soya leaves ...	79.5	6.0	0.5	10.8	3.2	72
Water cress ...	89.2	2.9	0.2	5.5	2.2	35

ROOTS AND TUBERS.

Beet root ...	83.8	1.7	0.1	13.6	0.8	62
Carrot	86.0	0.9	0.1	10.7	1.1	47
Colocasia	73.1	3.0	0.1	22.1	1.7	101
Onion, big ...	86.8	1.2	0.1	11.6	0.4	51
Onion, small ...	84.3	1.8	0.1	13.2	0.6	61
Parsnip	72.4	1.3	0.3	23.2	1.1	101
Potato	74.7	1.6	0.1	22.9	0.6	99
Radish (pink) ...	90.8	0.6	0.3	7.4	0.9	35
Radish (white) ...	94.4	0.7	0.1	4.2	0.6	21
Sweet potato ...	66.5	1.2	0.3	31.0	1.0	132
Tapioca	59.4	0.7	0.2	38.7	1.0	159
Yam (elephant) ...	78.7	1.2	0.1	18.4	0.8	79
Yam (ordinarty) ...	69.9	1.4	0.1	27.0	1.6	115

OTHER VEGETABLES.

Amaranth stem ...	92.5	0.9	0.1	3.5	1.8	19
Artichoke	77.3	3.6	0.1	16.0	1.8	79
Ash gourd	96.0	0.4	0.1	3.2	0.3	15
Bitter gourd ...	92.4	1.6	0.2	4.2	0.8	25
Bitter gourd (small variety)	83.2	2.9	1.0	9.8	1.4	60
Brinjal	91.5	1.3	0.3	6.4	0.5	34
Broad beans ...	82.4	4.5	0.1	10.0	1.0	59
Calabash cucumber ...	96.3	0.2	0.1	2.9	0.5	13
Cauliflower ...	89.4	3.5	0.4	5.3	1.4	39
Celery stalks ...	93.5	0.8	0.1	3.5	0.9	18
Cluster beans ...	82.5	3.7	0.2	9.9	1.4	56

Name of foodstuff.	Water.	Protein.	Fat.	Carbo-hydrate.	Mi-neral.	Calories per 100 gms.
Colocasia stems ...	93.4	0.3	0.3	4.1	1.2	21
Cucumber ...	96.4	0.4	0.1	2.8	0.3	14
Double beans ...	73.8	8.3	0.3	12.3	1.0	85
Drumstick ...	86.9	2.5	0.1	3.7	2.0	26
French beans ...	91.4	1.7	0.1	4.5	0.5	26
Ipomoea stems ...	93.7	0.9	0.2	3.4	1.8	19
Jack, tender ...	84.0	2.6	0.3	9.4	0.9	51
Jack fruit seeds ...	51.6	6.6	0.4	38.4	1.5	184
"Kovai" fruit, tender ...	93.1	1.2	0.1	3.5	0.5	20
Knol-knol	92.1	1.1	0.2	5.9	0.7	30
Ladies fingers ...	88.0	2.2	0.2	7.7	0.7	41
Leeks	78.9	1.8	0.1	17.2	0.7	77
Mango, green ...	90.0	0.7	0.1	8.8	0.4	39
"Nellikai" Amla ...	81.2	0.5	0.1	14.1	0.7	59
Onion stalks ...	87.6	0.9	0.2	8.9	0.8	41
"Parwar" ...	92.3	2.0	0.3	1.9	0.5	18
Peas, English ...	72.1	7.2	0.1	19.8	0.8	109
Plantain flower ...	90.2	1.5	0.2	5.0	1.2	28
Plantain, green ...	83.2	1.4	0.2	14.7	0.5	66
Plantain stem ...	88.3	0.5	0.1	9.7	0.6	42
Pumpkin	92.6	1.4	0.1	5.3	0.6	28
Rhubarb stalks ...	92.7	1.1	0.5	3.7	1.1	24
Ridge Gourd ...	95.4	0.5	0.1	3.7	0.3	18
"Singhara" or water chestnut ...	70.0	4.7	0.3	23.9	1.1	117
Snake-gourd ...	94.1	0.5	0.3	4.4	0.7	22
Spinach stalks ...	93.4	0.9	0.1	3.8	1.8	20
Sword beans ...	88.6	2.7	0.2	6.4	0.6	38
Tomato, green ...	92.8	1.9	0.1	4.5	0.7	27
Turnip	91.1	0.5	0.2	7.6	0.6	34
Vegetable marrow ...	94.8	0.5	0.1	4.3	0.3	20

FRUITS.

Name of foodstuff.	Water.	Protein.	Fat.	Carbo-hydrate.	Mi-neral.	Calories per 100 gms.
Apple	85.9	0.3	0.1	13.4	0.3	56
Banana	61.4	1.3	0.2	36.4	0.7	153
Bilimbi	93.9	0.5	0.2	4.8	0.2	23
Cashew fruit ...	87.9	0.2	0.1	11.6	0.2	48
Dates (Persian) ...	26.1	3.0	0.2	67.3	1.3	283
Figs	89.8	1.3	0.2	17.1	0.6	75

Name of foodstuff.	Water.	Protein.	Fat.	Carbo-hydrate.	Mineral.	Calories per 100 gms.
Grapes (Blue Variety) ...	85.5	0.8	0.1	10.2	0.4	45
Grape fruit (Triumph) ...	92.0	0.7	0.1	7.1	0.2	32
Grape fruit (Marsh's seedless) ...	85.5	1.0	0.1	10.0	0.4	45
Guava, country ...	6.1	1.5	0.2	14.5	0.8	66
Guava, hill... ...	85.3	0.1	0.2	8.1	0.6	38
Jack fruit	77.2	1.9	0.1	18.9	0.8	84
Jambu fruit (Rose apple)	78.2	0.7	0.1	19.7	0.4	3
Korukkapalli ...	80.8	2.6	0.3	15.9	0.4	77
Lemon	85.0	1.0	0.9	11.1	0.3	57
Lime	84.6	1.5	1.0	10.9	0.7	59
Mango, green ...	90.0	0.7	0.1	8.8	0.4	39
Mango, ripe ...	86.1	0.6	0.1	11.8	0.3	50
Mango, "Ankola" ...	85.9	1.0	0.1	12.5	0.5	55
Mangosteen ...	84.9	0.5	0.1	14.3	0.2	60
Melon, water ...	95.7	0.1	0.2	3.8	0.2	17
Orange	87.8	0.9	0.3	10.6	0.4	49
Palmyra fruit, tender	92.7	0.6	0.1	6.5	0.2	28
Papayya, ripe ...	89.6	0.5	0.1	9.5	0.4	40
Peaches	90.1	1.5	0.2	7.6	0.6	38
Pears, country ...	6.9	0.2	0.1	11.5	0.3	47
Pears, English ...	85.8	0.9	0.2	12.9	0.2	57
Pine apple ...	86.5	0.6	0.1	12.0	0.5	50
Plantain (ordinary) ...	73.4	1.1	0.1	24.7	0.7	104
Plantain (Red variety)	74.1	1.6	0.1	23.4	0.8	101
Plums (red variety) ...	89.8	0.7	0.2	8.9	0.4	40
Pomegranate ...	78.0	1.6	10.1	14.6	0.7	65
Pomeloe ...	88.0	0.6	10.1	10.2	0.5	44
Quince	85.7	0.3	0.1	11.9	0.3	49
Radish fruit ...	91.2	2.3	0.3	5.4	0.8	34
Raisins (preserved) ...	18.5	2.0	0.2	77.3	2.0	319
"Seetha Pazham" or Custard apple ...	73.5	1.6	0.3	23.9	0.7	105
Strawberry ...	87.8	0.7	0.2	9.8	0.4	44
Tomato, ripe ...	94.5	1.0	0.1	3.9	0.5	21
"Vikki Pazaham" or Wild olive ...	63.9	1.4	0.1	33.7	0.9	141
Wood apple ...	69.5	7.3	0.6	15.5	1.9	97
Tamarind, pulp ...	20.9	3.1	0.1	67.4	2.9	283
Zizyphus (Indian plum)	85.9	0.8	0.1	12.8	0.4	55

NUTS AND OIL SEEDS.

Name of foodstuff.	Water.	Protein.	Fat.	Carbo-hydrate.	Mi-neral.	Calories per 100 gms.
Almond	5.2	20.8	58.9	10.5	2.9	655
Cashew nut ...	5.9	21.2	46.9	22.3	2.4	596
Cocoanut	36.3	4.5	41.6	13.0	1.0	444
Gingally seeds ...	5.1	18.3	43.3	25.2	5.2	564
Ground nut ...	7.9	26.7	40.1	20.3	1.9	549
Ground nut roasted ...	4.0	31.5	39.8	19.3	2.3	561
Linseed seeds ...	6.6	20.3	37.1	28.8	2.4	530
Mustard seeds ...	8.5	22.0	39.7	23.8	4.2	541
Pistachio nut ...	5.6	19.8	53.5	16.2	2.8	626
Walnut	4.5	15.6	64.5	11.0	1.8	687

MISCELLANEOUS FOODSTUFFS.

Arecanut	31.3	4.9	4.4	47.2	1.0	248
Arrow-root flour (West Indian)	16.5	0.2	0.1	83.1	0.1	334
Betel leaves (piper betel)	85.4	3.1	0.8	6.1	2.3	44
Cocoanut, tender ...	90.8	0.9	1.4	6.3	0.6	40
Cocoanut water ...	95.5	0.1	0.1	4.0	0.4	17
Cooking oil ...	2.0	....	98.0	....	....	895
Cod liver oil ...	....	....	100.0	....	....	900
Halibut liver oil ...	....	....	100.0	....	....	900
Honey	26.0	0.5	....	73.0	0.3	325
Jaggery (Gur) ...	3.9	0.4	0.1	95.0	0.6	383
Jam	25.0	0.3	....	75.0	0.2	315
"Makhana" ...	12.8	9.7	0.1	76.9	0.5	348
Red Palm oil ...	....	....	100.0	....	....	900
Sago	12.2	0.2	0.2	87.1	0.3	351
Sugar	3.5	....	....	96.5	....	390
Sugar cane juice ...	90.2	0.1	0.2	9.1	0.4	39
Sugar cane preserves ...	8.1	0.6	0.1	78.4	1.8	317
Toddy, sweet ...	84.7	0.1	0.2	14.3	0.7	59
Toddy, sweet (cocoanut)	96.2	0.1	0.1	3.5	0.2	15
Toddy, fermented (cocoanut) ...	98.3	0.2	0.1	1.3	0.1	7
Yeast, dried ...	13.6	39.5	0.6	39.1	7.0	320

CONDIMENTS, SPICES, ETC.

Name of foodstuff.	Water.	Protein.	Fat.	Carbo-hydrate.	Mineral.	Calories per 100 gms.
Asafœtida ...	16.0	4.0	1.1	67.8	7.0	297
Cardamom ...	20.0	10.2	2.2	42.1	5.4	229
Cloves, dry ...	23.3	5.2	8.9	47.9	5.2	293
Cloves, green ...	65.5	2.3	5.9	24.1	2.2	159
Coriander ...	11.2	14.1	16.1	21.6	4.4	288
Cumin	11.9	18.7	15.0	36.6	5.8	356
Fenugreek seeds ...	13.7	26.2	5.8	44.1	3.0	333
Garlic	62.8	6.3	0.1	29.0	1.0	142
Ginger	80.9	2.3	0.9	12.3	1.2	67
Kandanthippili (Long pepper)	12.2	6.4	2.3	65.8	4.8	310
Lime peel ...	66.5	1.8	0.5	29.4	1.8	129
Mace	15.9	6.5	24.4	47.8	1.6	437
Mustard	8.5	22.0	39.7	23.8	4.2	541
Nutmeg	14.3	7.5	36.4	28.5	1.7	472
Omum	8.9	15.4	18.1	38.6	7.1	379
Pepper, green ...	63.4	4.8	2.7	27.3	1.8	158
Pepper, dry ...	12.9	11.5	6.8	49.5	4.4	305
Tamarind, pulp ...	20.9	3.1	0.1	67.4	2.9	283
Turmeric ...	13.1	6.3	5.1	69.4	3.5	349

APPENDIX II

Hindusthani and Bengali Nomenclatures of some common Foodstuffs

LEAFY VEGETABLES

ENGLISH	HINDUSTHANI	BENGALI
Amarnath, tender	Lal Choalai	Banopata Nate
Amarnath, Spined (Prickly)	Kantewali Choalai	Kanta Nate
Bengal Gram Leaves	Chana sag	Chola sag
Brussels Sprouts (a kind of cabbage)	Kobee	Kobee
Carrot leaves	Gajar sag	Gajar sag.
Celery	Ajwan Ka pata	Randhuni sag, chanu
Coriander leaves	Dhania sag	Dhane sag
Curry leaves	Gaudhela	Bursunga
Drumstic leaves	Saijan pata	Saijna pata
Fenugreek leaves	Methi sag	Methi sag
Garden cress	Halim	Halim (Chandra-sura)
Ipomea leaves	Kalmi sag	Kalmi sag
Lettuce	Salad sag	Salad pata
Mint	Paudina sag	Paudina sag
Puing (Red Malabar Night shade)	Puika sag	Pui sag
Rape leaves	Sarsoon sag	Sarisa sag
Safflower leaves	Kusumbar	Kusamphul, kajireh
Spinach	Palagka sag	Palang sag
Water cress	Halim	Halim

ROOTS AND TUBERS

ENGLISH	HINDUSTHANI	BENGALI
Beet root	Chukander	Beet
Carrot	Gajar	Gajar
Colocasia	Arwi	Kachu (Kalo kachu, Mankachu)
Radish	Muli	Mula

ENGLISH	HINDUSTHANI	BENGALI
Tapioca ...	... Simla Alu, Sakarkanda	Simla alu
Yam (elephant) ...	... Jangli alu, Zamin kand	Ol
Yam (Ordinary) ...	... Ratalu ...	... Ghet Kachu

OTHER VEGETABLES

Artichoke ...	... Hatichak ...	... Hatichak
Ash gourd ...	... Golkadu, Petha	... Kumra
Bitter gourd ...	... Karela ...	... Karela
Bitter gourd (Small variety)	Karela ...	... Uchchhe
Brinjal ...	... Baingan ...	... Begun
Broad beans ...	... Sem ...	... Makhan sim
Calabash cucumber (bottle or white gourd) ...	... Ghia kadu	... Lau
Kovai fruit ...	... Konduri ...	... Telakucha
Knol khol ...	... Kabi ...	... Kapi
Ladies fingers ...	... Bhindi ...	... Dherash
Leeks (Onion) ...	... Payaj ...	... Payaj
Nellikai (Amla) ...	... Amlika ...	... Amlaki
Parwar ...	... Kondree ...	... Telakucha
Plantain flower ...	... Kelaka phul	... Mocha
Plantain stem ...	... Keleka Tana	... Thor, Bharail
Pumpkin ...	.. Kaddu ...	... Kumra
Pubul ...	... Parbal ...	... Patal
Rhubarb ...	... Revanchini	... Reuchini
Ridge gourd ...	... Torai ...	... Jhinga
Snake gourd ...	.. Chachinda	... Chichinga
Sword beans ...	... Sem ...	... Kathsim
Turnip ...	... Shalgham	... Shalgom
Vegetable marrow	.. Safed Kaddu	... Chalkumra
Water chestnut ...	... Singhara	... Singhara

CEREALS

Cambu ...	... Bajra ...	... Bajra
Cholam ...	... Juar ...	... Juar
Maize, tender ...	... Makai, Makka	... Bhuttee

ENGLISH	HINDUSTHANI	BENGALI
Millet	Chin	China
Oat	Jai	Jai
Ragi	Mandua, Makra	Bajri, Murooa
Rice (raw)	Alwa chawal	Atap chowl
Rice (parboiled)	Usna chawal	Siddha chowl
Rice (puffed)	Marmura	Muri
Samai (Little millet)	Kutki	Kangni

PULSES

ENGLISH	HINDUSTHANI	BENGALI
Bengal Gram	Chana	Boot, chola
Black gram	Urd	Mashkalai
Cow gram	Labia bada	Barbati
Green gram	Mung	Mug
Horse gram	Kulthi	Kulti
Lentil	Masur	Musari
Peas	Matar	Matar
Red gram	Arhar	Arhar
Soya bean	Bhatwan	Gari Kalai

MILK AND ITS PRODUCTS

ENGLISH	HINDUSTHANI	BENGALI
Butter-milk	Matha.	Matha, Ghol
Curd	Dahi.	Dadhi
Cheese	Panir.	Panir

FRUITS

ENGLISH	HINDUSTHANI	BENGALI
Banana	Kela	Kala
Bilimbi	Kamrach	Kamranga
Cashew fruit	Kajuka phal	Hijli badam
Grape fruit	Bilati Batabi	Bilati Batabi, or Jambura
Jambu fruit	Gulabjamam	Gulab jam
Melon, water	Turbuz.	Tarmuj
Papayya	Papita	Pepa
Pomeloe	Batabi, chakatra	Batabi, Jambura
Quince	Bihi	Quince

NUTS AND OIL SEEDS

ENGLISH	HINDUSTHANI	BENGALI
Wood apple ...	... Kaith ...	... Badari, Kul
Zizyphus (Indian plum)	... Baer ...	... Kathbael
Almond ...	... Badam ...	... Bilati badam
Cashew nut ...	... Kaju ...	... Hijli badam
Gingelly seeds ...	... Cash Til ...	... Til
Linseed seeds ...	... Alsi ...	... Tishi
Pistachio nut ...	... Pista ...	... Pesta
Walnut ...	... Akhrot ...	... Akhrot

MISCELLANEOUS FOODSTUFFS

Arecanut ...	... Supari ...	... Supari
Jaggery ...	... Gur ...	... Gur
Toddy	... Tari ...	... Tari

CONDIMENTS AND SPICES

Asafœtida ...	... Hing ...	... Hing
Cardamom ...	... Elaychi ...	... Elachi
Cloves ...	... Laung ...	... Laung
Coriander ...	... Dhania ...	... Dhania
Cumin ...	... Zira ...	... Zira
Fenugreek seeds ...	... Methi ...	... Methi
Garlic ...	... Lashun ...	... Rashun
Ginger ...	... Adrak ...	... Ada
Long pepper ...	... Pipli ...	... Pipli
Mace	... Javitri ...	... Jayitri
Nutmeg ...	... Jaiphal ...	... Jaiphal
Omum	... Ajwan ...	... Joan
Pepper ...	... Kali mirich	... Gol marich
Turmeric ...	... Haldi ...	... Halud

APPENDIX III

LIST OF COMMON FOODSTUFFS RICH IN CALCIUM AND IRON.

Foodstuffs particularly rich both in Calcium and Iron:—

Cereals—Whole wheat flour, Ragi (Makra, Bajri).

Animal foods—Egg-yolk, Crab muscle.

Legumes—Dried beans—Bengal gram (Chola), Black gram (Kalai), Green gram (Mung), Khesari, Lentil (Musur), Red gram (Arahar), Soyabean.

Vegetables (Leafy)—Amarnath leaves (Lal sag), Gram leaves (Chola sag), Betel leaves (Pan), Cabbage-outer green leaves, Carrot leaves (Gajar pata), Celery (Ajwan pata, Randhuni sag), Coriander leaves (Dhania sag), Drumstick leaves (Saijna pata), Fenugreek leaves (Methi sag), Garden cress (Halim), Mint (Paudina), Neem leaves-tender, Parsley, Rape leaves (Sarisa sag), Spinach (Palang sag), Yeast.

Dried fruits and Seeds—Apricot (Khubani), Pestachio nut (Pesta), Walnut (Akhrot), Dates (Khejur), Gingelly seeds (Til), Mustard seeds (Sarisa), Tamarind pulp (Tetul).

Condiments—Asfœtida (Hing), Cardamom (Elachi), Cloves (Laung), Coriander (Dhania), Cumin (Jira), Fenugreek seed (Methi), Long pepper (pipli), Black pepper (Gol marich), Mace (Javitri), Omum (Joan), Turmeric (Halud).

Foodstuffs particularly rich only in Calcium:—

Animal foods—Milk (Cow, Buffalo, Goat), Curd (Dahi), Skimmed milk powder, Cheese.

Vegetables and Dried friuts—Artichoke (Hatichak), Beet-root, Curry leaves (Bursunga), Ipomea leaves (Kalmi sag), Lettuce-tender, Onion-big, Parsnips, Turnip tops (Salgom pata). Carrots (Gajar), Jack fruit seeds, Wood apple (Kathbael), Almonds, Currants.
apple (Kathbael), Almonds, Currants.

Foodstuffs particularly rich only in Iron:—

Animal foods—Glandular tissues (Liver, Spleen, Kidney, Heart).

Cereals—Bajra, Barley, Cholam (Juar), Maize flour, Oatmeal, Samai (China).

Vegetables and Dried fruis—Beet-green, Onion stalks, Mango-green, Peas-dry, Cashew nut (Hijli badam), Raisins (Kismis), Figs-dry, Prunes-dry, Cocoanut-dry, Jaggery (Gur).

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